TABLE OF CONTENTS

OVERSIGHT

Abbreviations Used in This Report

AGS	**Alternating Gradient Synchrotron**
ALARA	**As Low As Reasonably Achievable**
ARR	**Accelerator Readiness Review**
ASE	**Accelerator Safety Envelope**
AUI	**Associated Universities, Inc.**
BHG	**Brookhaven Group**
BNL	**Brookhaven National Laboratory**
CH	**DOE Chicago Operations Office**
DOE	**U.S. Department of Energy**
DP	**DOE Office of Defense Programs**
EH	**DOE Office of Environment, Safety and Health**
EM	**DOE Office of Environmental Management**
EPA	**Environmental Protection Agency**
ER	**DOE Office of Energy Research**
ES&H	**Environment, Safety, and Health**
FSS	**BNL Facility Safety and Support**
HFBR	**High Flux Beam Reactor**
NE	**DOE Office of Nuclear Energy**
NSLS	**National Synchrotron Light Source**
ORR	**Operational Readiness Review**
QA	**Quality Assurance**
RWP	**Radiation Work Permit**
SAD	**Safety Assessment Document**
SAR	**Safety Analysis Report**
SEAPPM	**BNL Safety and Environmental Administrative Policy and Procedures Manual**
S&EP	**BNL Safety and Environmental Protection Department**

Executive Summary

EVALUATION:	Office of Oversight Evaluation of Integrated Safety Management, as Applicable to Environment, Safety, and Health.
SITE:	Brookhaven National Laboratory, Upton, New York
DATES:	February - April 1997

Scope

The Department of Energy Office of Oversight evaluated the safety management program at Brookhaven National Laboratory, as implemented by the responsible management elements at DOE Headquarters—the Offices of Nuclear Energy, Energy Research, and Environmental Management; the Department of Energy Chicago Operations Office; the Department of Energy onsite office, known as the Brookhaven Group; the prime contractor, Associated Universities, Inc.; and selected subcontractors. The evaluation focused on four BNL facilities—the High Flux Beam Reactor, the Alternating Gradient Synchrotron, the National Synchrotron Light Source, and the Chemistry Department—and on selected environment, safety, and health programs, such as radiological protection and the groundwater protection program.

Background on BNL Groundwater Monitoring and Actions to Remediate Tritium Contamination

This evaluation is the second phase of Oversight activities at Brookhaven National Laboratory. In the first phase, the Assistant Secretary for Environment, Safety and Health dispatched a team to monitor activities related to tritium contamination in the groundwater at the High Flux Beam Reactor. The results of the first phase of the review were documented in a report issued in February 1997.

A number of management weaknesses identified during the first-phase review of the management of the tritium groundwater plume recovery effort were confirmed in this second phase. Examples included deficiencies in the prioritization of issues and timely implementation of commitments. Weaknesses were identified in the groundwater monitoring program, including an inadequate focus on environmental monitoring at operating facilities, insufficient prioritization and funding of monitoring wells, and poor coordination between sitewide environmental monitoring and environmental restoration programs. Although remaining weaknesses need to be resolved, the current Department of Energy and Brookhaven National Laboratory actions to eliminate the source and remediate the tritium contamination have been aggressive and appropriate.

Environment, Safety, and Health Management Evaluation

The evaluation found that the Department of Energy and Brookhaven National Laboratory have initiated efforts that have resulted in some improvements, particularly in areas where management has focused its attention, such as enhancement of conduct of operations at the High Flux Beam Reactor. The effectiveness and implementation of Department of Energy and Brookhaven National Laboratory environment, safety, and health initiatives, however, is limited by a number of weaknesses in Department of Energy Headquarters, Chicago Operations Office, Brookhaven Group, and Brookhaven National Laboratory management systems. The most significant issues include:

- Department of Energy Headquarters needs to clarify changing roles, responsibilities, and authorities related to Brookhaven National Laboratory; provide definitive and appropriate guidance on this responsibility of Department of Energy field management for oversight of contractor environment, safety, and health performance; and coordinate between the multiple program offices—the Offices of Nuclear Energy, Environmental Management, and Energy Research—in providing direction and funding to the Laboratory.
- The Department of Energy and Brookhaven National Laboratory need to strengthen the management processes and organizational infrastructure necessary to achieve management and contractual accountability for environment, safety, and health performance (including adherence to safety management policies, prioritization of issues and resources, and control of workforce hazards).
- The Department of Energy and Brookhaven National Laboratory need to focus on strengthening management systems for achieving balance between environment, safety, and health priorities and mission-related objectives. Attention must be directed toward ensuring that environment, safety, and health is an integral part of all site activities, and allocating appropriate management and funding support for environment, safety, and health.
- Brookhaven Group and Brookhaven National Laboratory management processes that are intended to establish environment, safety, and health priorities, track and resolve issues, and ensure the timely implementation of corrective actions, commitments, and regulatory requirements are in need of improvement. Existing processes do not ensure that the management and programmatic root causes of environment, safety, and health events and adverse performance trends are identified and resolved to prevent recurrence.
- Brookhaven National Laboratory has not established an effective work planning and control system to ensure that hazards associated with site activities, including some aspects of research and maintenance, are properly identified and integrated.

The Department of Energy, including Headquarters (Office of Nuclear Energy, Office of Energy Research, and Office of Environmental Management), Chicago Operations Office, and the Brookhaven Group, have defined environment, safety, and health policies and goals and communicated them to Associated Universities, Inc. In addition, the Chicago Operations Office has been progressive in embracing and implementing current Department of Energy initiatives and trends in management. For example, the Chicago Operations Office and the Brookhaven Group organizations have been restructured ("flattened") to streamline operations and facilitate coordination, and the Brookhaven Group has been empowered to manage site activities and safety. The Chicago Operations Office has also been focusing on contract reform, including the incorporation of performance metrics to monitor Brookhaven National Laboratory's environment, safety, and health performance.

Brookhaven National Laboratory is in the midst of implementing a number of recent initiatives intended to strengthen safety management and Environment, Safety, and Health performance. A three-tier internal assessment program, which includes internal safety inspections by line organizations, programmatic self-assessments by the line, and independent assessments by Associated Universities, Inc., has been modified to strengthen involvement by line management. Substantial improvements have been made in conduct of operations and in some aspects of experimental safety, particularly at the High Flux Beam Reactor. Other positive Brookhaven National Laboratory initiatives include the environment, safety, and health "revitalization" effort and changes in the procurement of subcontractor services to place more emphasis on safety performance.

The issues discussed above constitute a significant barrier to improving environment, safety, and health programs and have contributed to a situation where improvements in one facility or program are rarely extended to other facilities or programs that have similar problems. While these weaknesses warrant significant management attention, nothing was identified in the course of this evaluation that would warrant curtailment of Brookhaven National Laboratory operations.

Conclusion

Department of Energy Headquarters, the Chicago Operations Office, and Brookhaven Group need to clarify their respective roles and responsibilities in the management oversight of Laboratory operations and safety. Strategic realignment within the Department has shifted many responsibilities and authorities to the field, including Chicago Operations Office and Brookhaven Group, creating confusion in Headquarters about remaining roles, responsibilities, and authorities. This situation is exacerbated at a multi-program laboratory, where effective coordination between the Offices of Nuclear Energy, Environmental Management, and Energy Research is essential to achieve consistency in policy and program direction, better coordination between Brookhaven National Laboratory site programs such as environmental restoration and sitewide groundwater monitoring, and more effective and efficient allocation of funding and resources essential to environment, safety, and health.

Department of Energy Headquarters should also reconsider its direction, under contract reform, to reduce direct oversight of contractor environment, safety, and health performance and to rely primarily on performance metrics. While these metrics have value, particularly when tied to the operating contract, they do not serve as an effective mechanism to monitor the contractor's day-to-day environment, safety, and health performance. Effective Department of Energy line management oversight is even more essential in the absence of effective and sustained environment, safety, and health performance and a strong contractor self-assessment program. Coordinated and effective Department of Energy line management oversight is needed to implement the Department of Energy's ultimate responsibility for site operations, and to assure effective protection of the public, the workers, and the environment.

In a recent internal report, Brookhaven Group described Brookhaven National Laboratory's approach to environment, safety, and health as relatively informal, with characteristics of "a university atmosphere." It is appropriate and desirable to be creative and flexible in designing and implementing environment, safety, and health programs in different work settings. However, this evaluation found that the informal atmosphere was not conducive to providing the level of discipline and control to ensure protection of the public, the workers, and the environment across Brookhaven National Laboratory activities.

Brookhaven National Laboratory, a world-class laboratory that has produced cutting edge scientific and medical research, has not kept pace with contemporary expectations for protection of the public, the workers, and the environment. Brookhaven National Laboratory's performance is lagging in areas such as a disciplined approach to site activities, systematic hazards analyses and work planning, and monitoring and protection of the environment.

Improving safety management at Brookhaven National Laboratory, creating an appropriate balance between environment, safety, and health and mission-related priorities, and creating a strong safety culture will require significant commitment. Within the Brookhaven National Laboratory organization, this commitment must begin at the Associated Universities, Inc. corporate and Laboratory Director level, permeate downward through the entire organization, and extend to all potentially hazardous activities. Leadership needs to be demonstrated by significantly increasing management involvement and accountability; making environment, safety, and health an integral part of all site activities, including research, operations, and maintenance; and increasing Department of Energy and Brookhaven National Laboratory management support for prioritization and appropriate levels of funding for the upgrade and maintenance of structures and systems; environment, safety, and health issues, commitments and requirements; environmental monitoring; and environment, safety, and health training and retraining.

As Brookhaven National Laboratory prepares to celebrate its fiftieth anniversary, a renewed level of commitment to environment, safety, and health, when combined with the many improvement initiatives already in place and the momentum and cooperation resulting from the tritium plume recovery effort, could significantly improve safety performance, aid in restoring stakeholder confidence and support, and help assure continuing the mission and contribution of this Laboratory to scientific and medical research into the twenty-first century.

OPPORTUNITIES FOR IMPROVEMENT

Strengthen CH, BHG, and BNL management leadership, visibility, and involvement in managing ES&H. Senior DOE and contractor managers ensure the understanding and effective implementation of ES&H initiatives and requirements and increase management presence in the facilities. Senior managers also need to ensure that they retain ultimate responsibility and authority for priorities and key ES&H decisions.

Clarify roles, responsibilities, and authorities within BHG and BNL and strengthen organizational, management, and individual accountability for ES&H performance. DOE and BNL should consider modifying the AUI contract to clarify performance expectations and incorporate improved systems for managing ES&H performance. BNL should establish single point accountability (i.e., responsibility assigned to an individual) for ES&H responsibilities, commitments, and corrective actions.

Strengthen DOE's monitoring and assessments of BNL ES&H performance and safety management. The roles and responsibilities of DOE Headquarters program offices, CH, and BHG should be clearly delineated. ES&H expectations should be clarified, including responsibilities to monitor the effectiveness of key BNL ES&H management processes, such as allocation of ES&H funding and hazards analyses and control. Such assignments should include a more formal and structured approach to BHG assessments and surveillances.

Strengthen management systems and procedures used by BHG and BNL to establish corrective actions and to prioritize, track, and implement corrective actions, commitments, and lessons learned. Improve mechanisms that address commitments, corrective actions, and lessons learned, as well as procedures to examine problems and prevent recurrences. An issues tracking system should be established to assure that issues are properly captured, tracked, completed as scheduled, and verified to be effectively implemented.

Establish a more structured, standards-based approach to the planning and control of work and related hazards across diverse organizations, facilities, and activities. Beginning at the AUI corporate and Laboratory Director's level, BNL should clearly communicate ES&H performance expectations, endorse key ES&H initiatives, and strengthen the hierarchical approach to site requirements. BNL should also institutionalize the five core functions of integrated safety management, strengthen control of experiments, and increase worker involvement in safety.

Strengthen the implementation of BNL sitewide training and qualifications essential to safety management and ES&H performance. BNL should provide a comprehensive and appropriate level of ES&H training and retraining for senior managers, ES&H managers, research facility users and subcontractors, and supervisors and work planners.

DOE Headquarters, including EH, program offices, and Field Management, should examine the issues raised on this integrated safety management evaluation and identify actions needed to address their complex-wide implications. Efforts to restructure methods for funding ES&H-related activities and ensure the upkeep of facilities and infrastructure at multi-program laboratories should be accelerated. DOE Headquarters should also emphasize contract reform efforts, ensure that effective measures to ensure accountability and meaningful rewards and sanctions are in place for not-for-profit institutions, assess appropriateness of relying on performance metrics as the major means of evaluating contractor ES&H programs, review and improve mechanisms for holding subcontractors accountable for ES&H performance, review "gaps" in funding at multi-program sites, identify areas where Headquarters needs to better coordinate implementation of responsibilities, and clarify expectations for conforming with revised DOE orders and the order/rules exemption processes.

1.0 Introduction

The Office of Environment, Safety and Health conducted an integrated safety management evaluation at Brookhaven National Laboratory (BNL) from February to April 1997.

BNL is a multi-program research laboratory that receives programmatic direction from several DOE program offices.

The U.S. Department of Energy (DOE) Office of Environment, Safety, and Health (EH) conducted an independent oversight evaluation of safety management at Brookhaven National Laboratory (BNL) from February to April 1997. The purpose of the evaluation was to determine how effectively DOE and contractor line management have implemented an integrated safety management system and environment, safety, and health (ES&H) program at BNL.

BNL was established in 1947 as a laboratory to advance scientific research. The Laboratory carries out basic and applied research in high-energy, nuclear, and solid state physics; fundamental material and structural properties and interactions of matter; nuclear medicine; biomedical and environmental sciences; and selected energy technologies.

As one of several DOE multi-program laboratories, BNL receives programmatic direction and from many DOE program offices, including Energy Research (ER), Nuclear Energy (NE), Environmental Management (EM), Defense Programs (DP), Nonproliferation and National Security, Fossil Energy, and the Office of Science Education and Technical Information. BNL also performs work for other U.S. government agencies, other countries, and industry under a variety of cost-reimbursement arrangements. Management of multi-program laboratories presents complex issues of DOE sponsorship, direction, leadership, and funding. Ensuring adequate funding for institutional ES&H program needs, maintenance of site infrastructure, and costs associated with facility operations (which include costs that occur as facilities age, and require refurbishing or decommissioning) is a particular challenge because such costs are not directly

TERMINOLOGY

Safety management refers to those systems required to ensure that an acceptable level of protection of the public, workers, and environment is maintained throughout the life of a facility or operation. The term "safety," when used in the context of safety management or the safety management program, specifically includes all aspects of environment, safety, and health.

Line management refers to the chain of command that extends from the Secretary of Energy through the Deputy Secretary or Under Secretary to the cognizant secretarial officers, DOE operations office managers, and contractors. Line management consists of DOE and contractor personnel organizationally or contractually responsible for work or job tasks (see Figures 1 and 2).

Integrated safety management system refers to a comprehensive and coordinated program of ES&H expectations and activities. DOE's recently issued policy, DOE Policy 450.4, Safety Management System, defines six components of an integrated safety management program: 1) the objective, 2) guiding principles, 3) core functions, 4) mechanisms, 5), responsibilities, and 6) implementation. These components provide the framework for Oversight's evaluation of the BNL safety management program (see Figure 3).

associated with individual programs or projects. Such activities are typically funded from "overhead" accounts (also referred to as indirect costs). There is continual pressure to reduce overhead costs so that funds can be applied to the projects that directly support mission activities.

Figure 1 shows a simplified view of the DOE and contractor organizations that have key roles in managing activities at BNL. Figure 2 shows simplified versions of the Chicago Operations Office (CH)/Brookhaven Group (BHG) and BNL organizational structures.

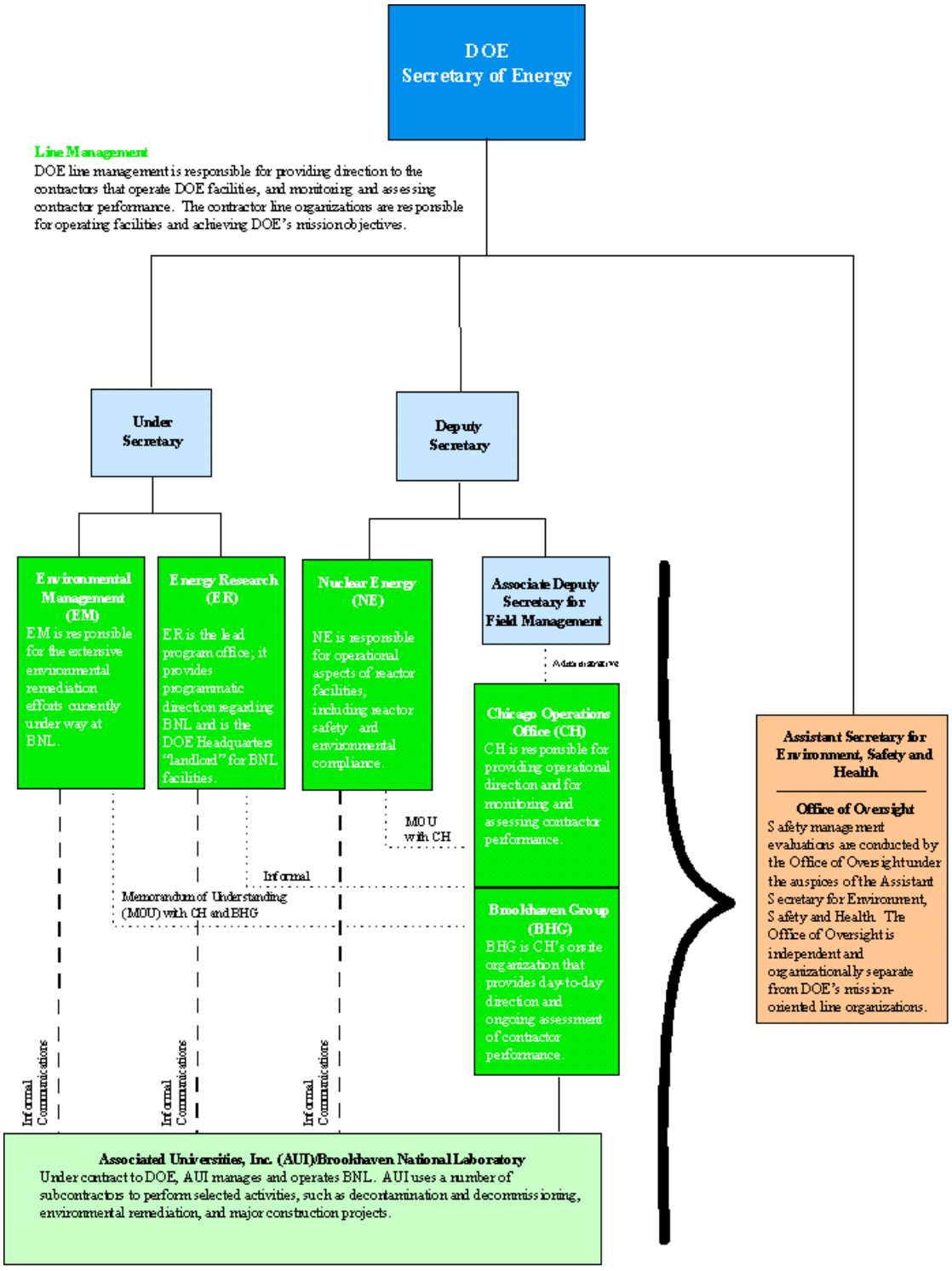


Figure 1. Organizations With Responsibilities at Brookhaven National Laboratory

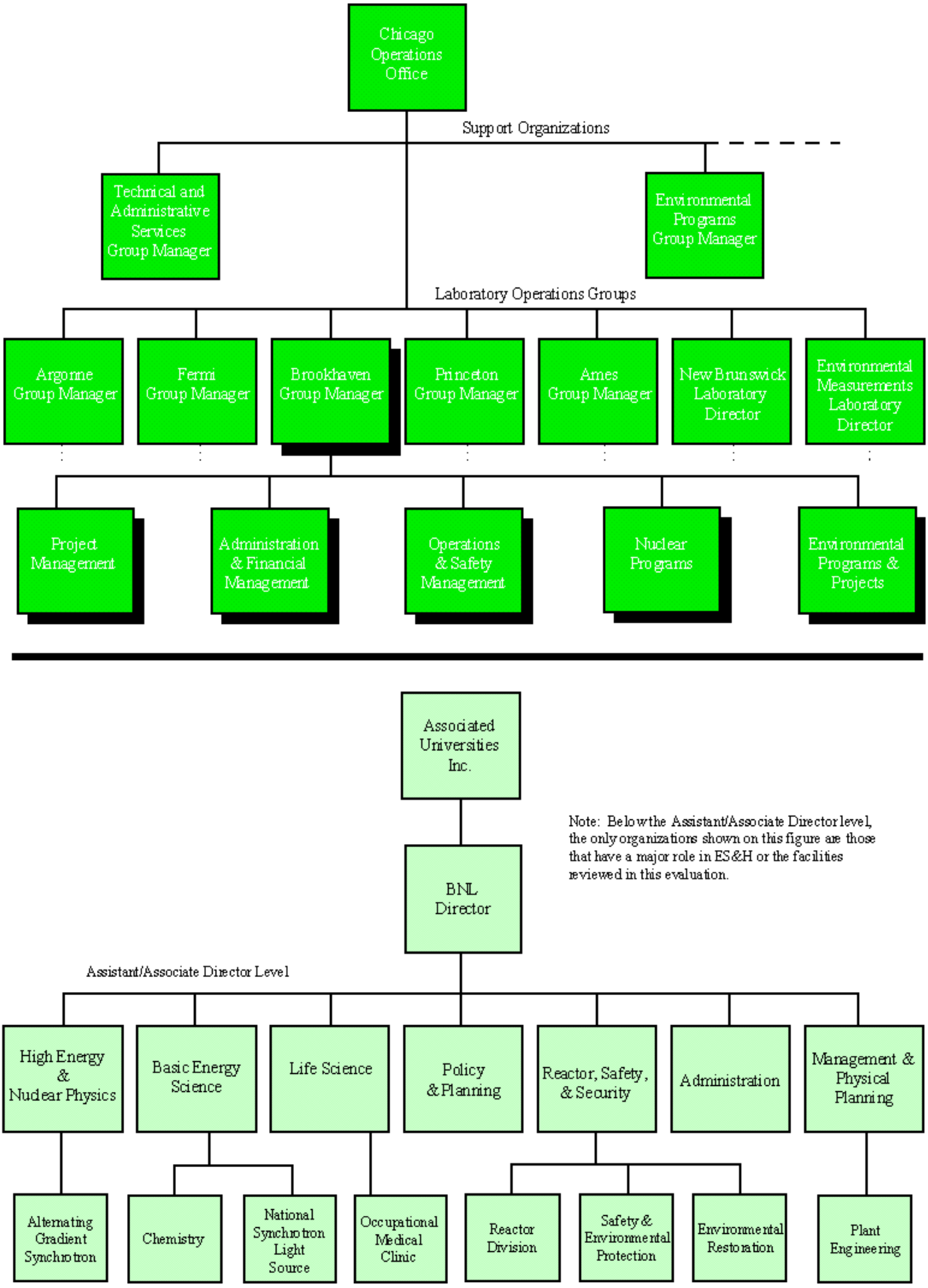


Figure 2. Brookhaven Group and Brookhaven National Laboratory Organizations

ORGANIZATIONS RESPONSIBLE FOR LABORATORY OPERATIONS

HEADQUARTERS: The cognizant secretarial office is the Office of Energy Research (ER). The Office of Environmental Management (EM) and Office of Nuclear Energy (NE) also have significant program management responsibilities in the areas of environmental restoration and reactor facilities, respectively.

CHICAGO OPERATIONS OFFICE (CH): CH manages activities at BNL, as well as a number of other sites (e.g., Argonne National Laboratory-East and West, Ames Laboratory, Fermi National Accelerator Laboratory, Princeton Plasma Physics Laboratory, Environmental Measurements Laboratory and New Brunswick Laboratory). CH is located in Argonne, Illinois, and has laboratory operations groups (area offices) at most of its major sites. CH has laboratory operations groups at each of its major sites (e.g., BHG at BNL) to provide a continuous onsite presence and provide day-to-day direction to contractors. Some ES&H support functions are performed by CH personnel in Illinois, while most ES&H functions have been delegated to the laboratory operations groups.

BROOKHAVEN GROUP (BHG): BHG is CH's laboratory operations group at BNL. BHG provides day-to-day safety management direction at BNL, with support from CH. BHG consists of about 42 personnel, about half of whom have significant ES&H-related responsibilities.

ASSOCIATED UNIVERSITIES, INC (AUI): The prime contractor for BNL is AUI, which has operated BNL since its inception in 1947. AUI also operates the National Radio Astronomy Observatory for the National Science Foundation. AUI is a not-for-profit corporation that was formed by nine universities (Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, University of Pennsylvania, Princeton, University of Rochester, and Yale) and now encompasses 26 universities.

BROOKHAVEN NATIONAL LABORATORY: As a national laboratory, BNL facilities and equipment are owned by the U.S. government and operated by contractor employees under a contract with AUI. The BNL Director reports to AUI. BNL has seven Associate and Assistant Directors who report to the Director and have responsibility for managing programs in their areas of responsibility (see Figure 2).

SUBCONTRACTORS: Major subcontractors and their primary functions are: CDM Federal Programs, environmental restoration activities; Conroy Contracting, miscellaneous construction; Hendrickson Brothers Construction, sanitary sewer upgrade; IT Corporation, environmental restoration activities; and J. Kokolakis, construction. NOTE: As used in this report, "AUI" refers to the corporate entity that has the contract to operate BNL on behalf of DOE. When used to refer to an organization, "BNL" refers to the contractor employees that are directly involved in operating BNL. "BNL" is also used to refer to the facilities and property that constitute the laboratory.

Scope

This safety management evaluation of BNL focuses on the effectiveness of DOE Headquarters program offices, CH, BHG—the onsite DOE office, Associated Universities Incorporated (AUI), BNL, and selected BNL subcontractors in implementing the objectives, principles, and core functions of an integrated safety management system.

The integrated safety management evaluation is a "top to bottom" review of the ES&H management organizations shown in Figure 1. It encompasses the organizations responsible for BNL from the DOE Headquarters program offices to the DOE operations office, to the managing and operating contractor, to subcontractors, and ultimately to the workers at selected facilities. The evaluation also samples the effectiveness of ES&H programs as they are translated from the identification of applicable policies to their implementation by the worker on the "shop floor."

The evaluation addresses safety management system effectiveness from the Headquarters level to the worker.

The basis for this evaluation is a conceptual framework, or template, that characterizes the principles, programs, and disciplines that are essential elements of a sound safety management program. This conceptual framework encompasses the objectives, principles, and functions for integrated safety management systems described in DOE Policy 450.4, Safety Management System. Figure 3 shows these components.

The fundamental premise is that line management is responsible and accountable for environment, safety, and health (ES&H) programs.

This approach is based on the fundamental premise that line managers are responsible and accountable for managing ES&H through proper work planning, hazard analyses, hazard control, and ongoing self-assessments of the efficacy of implemented controls. This template can accommodate the wide range of operations, hazards, and management styles at DOE facilities.

Component 1
Objectives

Systematically integrate safety into work practices at all levels

Component 2
Principles

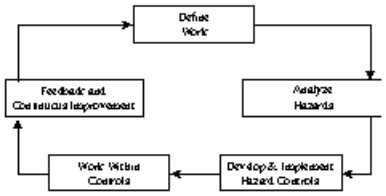
Fundamental policies that guide Department and contractor actions, from development of safety directives to performance of work

Component 3
Functions

Structure to perform work with rigor commensurate with hazards

The Department and contractors must systematically integrate safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment. This is to be accomplished through effective integration of safety management into all facets of work planning and execution. In other words, the overall management of safety functions and activities becomes an integral part of mission accomplishment.

1. Line Management Responsibility for Safety
2. Clear Roles and Responsibilities
3. Competence Commensurate with Responsibility
4. Balanced Priorities
5. Identification of Safety Standards and Requirements
6. Hazards Controls Tailored to Work Being Performed
7. Operations Authorization



The objective, guiding principles, and core functions of safety management shall be used consistently in implementing safety management throughout the DOE complex.

The mechanisms, responsibilities, and implementation components are established for all work and will vary based on the nature and hazard of the work being performed.

Component 4
Mechanisms

Systems defining how functions are performed

Component 5
Responsibilities

Defined and documented responsibilities and approval process commensurate with hazards

Component 6
Implementation

Actual planning, performance and assessment of work

Figure 3. Components of DOE's Integrated Safety Management System

OVERVIEW OF BROOKHAVEN NATIONAL LABORATORY

MISSION: BNL supports implementation of the DOE scientific and technical role as part of the national energy strategy. As a non-defense laboratory, BNL is dedicated to basic and applied investigation in a multitude of scientific disciplines, including experimental and theoretical physics, medicine, chemistry, biology, environmental research, and engineering. BNL was originally established to bring the resources of American academia and government together to create an institution that could pursue research and build facilities that would be beyond the scope of any single university. Annual funding for BNL is about $400 million.

ACTIVITIES: BNL operates two small nuclear reactors for experiments and medical diagnostic and treatment purposes. It also operates and constructs national particle accelerator facilities for high-energy physics, chemistry, biology, and materials research. Experiments are conducted in a wide range of areas, such as high energy collisions, radiobiology, photochemistry, and trace chemical composition. Many of the research activities at BNL are designed and conducted by university and industry users, with BNL maintaining the facilities and ensuring that provisions are in place to perform the activities safely.

LOCATION: BNL is located close to the geographic center of Suffolk County on Long Island, about 60 miles east of New York City. The land area adjacent to the site is a combination of forest, cultivated land, and residential housing development. STAFFING: Full-time staff of approximately 3,500 employees includes about 1,250 scientists and engineers, 550 administrative staff, 900 technical staff, and 800 support staff. In addition, the site supports an annual resident population of 1,500 individuals, predominantly project collaborators, consultants, users, and students involved in short-term experiments.

MAJOR FACILITIES: Major BNL facilities include the High Flux Beam Reactor (HFBR), the Brookhaven Medical Research Reactor (BMRR), the Alternating Gradient Synchrotron (AGS) complex, the National Synchrotron Light Source (NSLS), and the Hazardous Waste Management Facility. The two reactors and the two synchrotrons (also referred to as accelerators) are used for a variety of research, most notably in high and medium energy physics, isotope production, material science, medical science, solid state physics, chemistry, biology, environmental science, and geo-science. The Hazardous Waste Management Facility is the central facility for the processing, neutralization, and storing of radioactive wastes, Resource Conservation and Recovery Act (RCRA) hazardous wastes, and mixed wastes generated throughout BNL. A number of major construction activities are ongoing; major projects involving the Relativistic Heavy Ion Collider and the new Hazardous Waste Management Facility are near completion.

HAZARDS: The potential sources of radioactivity include the HFBR (a heavy water moderated reactor that operates up to 30 MWt), the BMRR (intermittent operations up to 3 MWt), operations involving irradiated spent reactor fuel, synchrotron activities, and radioactive and mixed wastes. Chemical and biological hazards include a wide variety of toxic materials used in experiments and research, oils contaminated with polychlorinated biphenyls (PCBs), acids, caustic materials, and various chemicals and solvents used in laboratories and maintaining BNL facilities and equipment. Construction and decontamination and decommissioning activities and work in areas with chemical processes, high voltage, heavy equipment, high energy steam, rotating machinery, magnetic sources, and cryogenic processes also present potential hazards.

ONGOING ENVIRONMENTAL REMEDIATION EFFORTS: BNL was placed on the National Priorities List (Superfund) in December 1989 and is subject to an interagency agreement involving DOE, the U.S. Environmental Protection Agency, and the New York State Department of Environmental Conservation. Sources of contamination include various BNL facilities, inactive landfills, disposal pits, stormwater runoff recharge basins, underground storage tanks, and site sewer pipes. Organic chemical and radiological soil contamination at some BNL facilities has migrated into the aquifer that serves as a sole source of water for many Suffolk County residents. Characterization and remediation of this contamination is ongoing to protect health and limit liability. In response to a 1995 independent technical review chartered by CH and negative public reaction to the contaminated groundwater, BNL's environmental program underwent strategic redirection and adopted a more structured approach. Specifically, BHG and BNL placed priority on mitigating the liability associated with the offsite contaminated groundwater; drinking water is being provided to some residents; offsite and site-boundary monitoring wells are being used to assess contamination levels; pump-and-treat operations are being implemented at the BNL site boundary to stop further contaminant migration offsite and to remove contaminants from the aquifer; interactions with stakeholders are more formal and more frequent; and waste minimization activities are being emphasized.

The components of the integrated safety management program, as defined in January 1996 DOE policy, are essential elements of any ES&H program, and each DOE site should currently have most of the elements in place. Oversight recognizes that BNL, as well as other DOE facilities, are in the very early stages of formally integrating the components into a system, such as envisioned in the new policy, and that full integration will take some time.

As part of the feedback/improvement component of integrated safety management, this evaluation is intended to provide DOE and contractor managers with an independent assessment of the status of their safety management program. Key elements of integrated safety management, including the guiding principles and core functions, were examined to evaluate which elements are functioning effectively and identify areas that need improvement and management attention.

The evaluation focused on the High Flux Beam Reactor (HFBR), accelerators, and the Chemistry Department.

A selected sample of BNL facilities was evaluated to understand how the guiding principles and core functions of safety management are actually implemented: the High Flux Beam Reactor (HFBR), the Alternating Gradient Synchrotron (AGS), the National Synchrotron Light Source (NSLS), and the Chemistry Department. The safety management evaluation examined selected ES&H programs, such as conduct of operations, occupational radiological protection, industrial safety/hygiene, maintenance, groundwater protection, environmental radiological protection, occupational health, surface water, and waste management. These facilities and ES&H programs were selected based on Oversight's planning process (which considered previously identified weaknesses, current BNL activities, and DOE and BNL management initiatives) to provide a broad perspective of the safety management program at BNL.

Areas of special focus were selected based on a review of previous assessments and events at BNL, including a 1988 Environmental Survey and the TRISTAN fire.

The Oversight team identified five areas for additional emphasis: groundwater monitoring; work planning and control (including experimental safety); issues management; control of subcontractor safety performance; and employee involvement in safety and health. These focus areas were selected based on an extensive Oversight planning effort that included analysis of BNL occurrence reports, interviews of management and staff, and review of a number of previous assessments at BNL.

The earliest assessment of BNL ES&H programs reviewed was a 1988 Environmental Survey Preliminary Report by the DOE Headquarters Office of Environment, Safety and Health (EH). The Environmental Survey was one of the earliest attempts to obtain an overview of environmental problems at DOE facilities; it addressed legacy environmental problems of 35 major DOE sites. While there was no formal followup by EH to the Environmental Survey, the results were instrumental to the genesis of DOE's Office of Environmental Management. The Oversight team also reviewed other more recent EH reviews, including the 1990 Tiger Team Assessment of ES&H Programs, the 1993 ES&H Progress Assessment (which evaluated followup of the Tiger Team results), the 1993 EH Spent Fuel Vulnerability Report, and assessment

[1] On March 31, 1994, a small fire occurred at the BNL High Flux Beam Reactor. The fire involved the TRISTAN experiment, which was one of several experiments set up on the experimental floor of the reactor at the time. The experiment involved exposing small amounts of fissile material to a beam of neutrons from the reactor, inside a heated chamber within a vacuum vessel. The fire was confined to the TRISTAN experiment shield block enclosure, and had no impact on the reactor. Seven facility personnel required decontamination of skin and clothing, but there was no internal contamination. Radioactive noble gases (18 millicuries) and iodine (54 microcuries) were released to the environment. The *Type B Investigation of the March 31, 1994 Fire and Contamination at the TRISTAN Experiment, High Flux Beam Reactor, Brookhaven National Laboratory, Upton, New York,* provides more detailed information on the event, causes, and recommendations.

reports associated with the 1994 fire at the TRISTAN experiment[1] within the HFBR. These previous assessments identified a number of significant issues in environmental compliance, environmental degradation, safety performance, and other areas that were deemed appropriate for further investigation.

As a part of this integrated safety management evaluation, the Office of Oversight developed a field report that documents the evaluation of DOE and BNL performance with respect to the core functions of safety management (i.e., defining work, analyzing hazards, developing controls, working within the controls, and providing feedback) and specific ES&H programs. The field report also provides further information supporting the evaluation of the management principles, which are the primary emphasis of this report.

Ongoing Oversight Evaluation of Groundwater Tritium Plume Recovery Activities

In January-February 1997, the Office of Oversight conducted an interim review of tritium contamination of groundwater around the HFBR. In January 1997, groundwater samples taken from recently installed monitoring wells south of the HFBR indicated elevated tritium levels. Concerns associated with this tritium contamination prompted EH to accelerate the original schedule for the Office of Oversight safety management evaluation at BNL and to conduct the interim review.

The interim review was intended to provide DOE management and other interested parties with a timely review of DOE and BNL effectiveness in dealing with the tritium contamination in the immediate vicinity of the HFBR.

In February 1997, Oversight issued an interim report on BNL management of tritium groundwater contamination at the HFBR.

The results of the interim review were documented in a report entitled *Interim Report on the Office of Environment, Safety and Health Oversight of Groundwater Tritium Plume Recovery Activities at the Brookhaven National Laboratory*, which was issued in February 1997. The results of the interim review indicated that there had been significant delays in installing monitoring wells south of the reactor after a need for such monitoring was identified, and noted that BNL management initially had problems in developing a coordinated approach to the tritium issue CH has provided an action plan to EH based on the opportunities for improvement identified in the interim report.

This second phase of the integrated safety management evaluation combines the insights from the review of the HFBR tritium contamination with the reviews of additional facilities and examination of other aspects of the ES&H program to provide a systematic assessment of the overall status of safety management programs at BNL. The Office of Oversight will continue to monitor progress and actions at BNL and will perform additional onsite reviews as needed to ensure that appropriate corrective actions are effectively implemented.

STATUS OF ACTIONS TO REMEDIATE THE HFBR TRITIUM PLUME

The interim report, published in February 1997, discussed the status of tritium plume remediation actions at that time. It also identified four opportunities for improving management of the tritium problem and a number of specific actions to be considered. The following provides an update of the developments that have occurred since the interim report was issued with respect to each of the four opportunities for improvement.

1. **Expedite tritium plume source resolution.** At the time of the interim report, the source of the tritium was still in question and there was no specific plan to eliminate the source. Since then, DOE and BNL have expedited their efforts to resolve the source and developed a specific plan. The primary near-term objective is to eliminate the source by shipping the spent fuel off site and emptying and draining the canal at the earliest possible date.
   - All remaining fuel in the spent fuel canal and reactor is scheduled for shipment to the Savannah River Site. Fuel shipments are scheduled to begin in May 1997 and be complete by the end of 1997; the canal will be drained immediately after the last shipment.
   - DOE line management and BNL have determined that there is a high degree of certainty that the primary source of contamination is the spent fuel canal. Testing and modeling results indicate that the fuel canal is probably leaking at a rate of 6 to 9 gallons per day.
   - Efforts are under way to definitively confirm the source(s) of the tritium plume, including drilling horizontal wells under and adjacent to the fuel canal.
   - A systematic evaluation of all potential tritium sources is in progress, including a review of engineering data and historical records. Inspection of reactor building seals is in progress, including seams, drain plugs, and floor penetrations.
   - An engineering proposal to install a stainless steel liner and leak detection system for the spent fuel canal is under development.
2. **Expedite mitigation and remediation of the tritium plume.**
   At the time of the interim report, four possible remedial action strategies were under consideration. A "pump and treat" option has been proposed, and an appropriate plan for mitigation of the plume has been developed.
   - Based on the additional monitoring (including new wells) performed since the interim evaluation, BNL has determined that the "leading edge" of the plume (defined as less than the Environmental Protection Agency drinking water standard of 20,000 pCi per liter) extends about 2300 feet south of the reactor (to between Roland Street and Weaver Drive) and has been developing for about 12 years.
   - Piping has been installed to permit pumping the "leading edge" of the plume. The tritiated groundwater pumped by this system will be discharged into an existing recharge basin and controlled and monitored by the ongoing environmental restoration program. It is not physically possible to separate tritium from ordinary water. The groundwater will be diluted so that the tritium concentration is below the drinking water standard The groundwater will also be treated using charcoal to remove volatile organic compounds (from other sources).
   - There is a commitment to begin pumping the plume in April 1997, contingent on regulatory approval. The Suffolk County Department of Health Services, the Environmental Protection Agency, and the New York State Department of Environmental Conservation will review the actual implementation and groundwater modeling results prior to the commencement of operations.
3. **Ensure a structured DOE and BNL management review and approval process.** Weaknesses in the review and approval process for prioritizing and funding ES&H upgrades and projects contributed to delays in installing the monitoring wells and initial problems in developing a coordinated approach to resolution of the tritium issue. An improved approach to decision making has recently been developed and is being implemented.
   - The revised decision-making approach includes formalization of requests for decisions and a systematic presentation of options to DOE and BNL management. Advantages, disadvantages, risks, safety, regulatory commitments, costs, and schedules are specifically addressed.
   - Coordination among BNL, BHG, CH, NE, ER, EM, and EH has been strengthened to ensure that these organizations participate in the tritium remediation project decision making process.
4. **Incorporate lessons learned from the tritium event and its chronology to improve BNL groundwater programs.** BHG and BNL have committed to evaluate the existing prioritization systems and communications related to environmental monitoring and to use historical data and incorporate lessons learned to improve groundwater protection programs.
   - BNL is evaluating existing historical groundwater data to identify any additional sources that may require additional attention.
   - BNL has committed to prepare and implement a comprehensive sitewide groundwater monitoring plan and to install downgradient wells at those operating facilities that could potentially impact groundwater.
   - BNL is conducting a groundwater vulnerability review at each BNL facility.
   - BHG will evaluate and revise the AUI contract clauses to emphasize groundwater protection.
   - BHG and BNL will evaluate funding mechanisms and prioritization systems to ensure that ES&H priorities are properly considered, and make adjustments as needed. The BNL Director has appointed a community representative to evaluate and make recommendations for improving existing budget priorities.
   - CH will examine its other sites to identify similar issues with funding and prioritizing ES&H programs; it has notified its other sites and encouraged them to perform self-assessments.

SUMMARY ASSESSMENT: Since the interim review, DOE and BNL approaches to tritium contamination source resolution and remediation have been aggressive and appropriate. Through the combined efforts of EM, ER, NE, EH, CH, BHG, and BNL, the opportunities for improvement identified as part of EH's interim review have either been completed or specific plans with clear milestones have been established. Although continued attention is needed, the involvement and cooperation of DOE's senior management, DOE program offices, CH, BHG, and BNL in a joint effort to resolve the tritium issue is encouraging.

2.0 Guiding Principles of Safety Management

The seven guiding principles provide the criteria for evaluating line management performance.

The guiding principles of safety management provide the essential criteria for evaluating line management's performance in ensuring an effective safety management program, identifying the requirements that apply to work processes, and ensuring that the necessary analysis and controls have been established to ensure that work can be performed safely and in an environmentally sound manner. The guiding principles also provide a useful framework and tool for analyzing strengths and weaknesses in the implementation of safety management programs; weaknesses in program implementation can generally be related directly to weaknesses in management's implementation of the guiding principles.

Line Management Responsibility for Safety

GUIDING PRINCIPLE #1: Line management is directly responsible for the protection of the public, the workers, and the environment.

CH, BHG, and BNL line management have recognized that there are weaknesses in safety management at BNL and, over the past few years, have developed a number of initiatives to improve ES&H programs. As discussed in the following paragraphs, these initiatives are in various stages of implementation; some these initiatives have had positive impacts while others have not been effectively implemented.

DOE has been effective in establishing and communicating ES&H goals and incorporating metrics into the BNL contract.

DOE, including Headquarters (NE, ER, and EM), CH, and BHG have been effective in defining ES&H policies and goals and communicating them to AUI and BNL. CH has established a strategic goal to achieve results-oriented, cost-effective, environmentally sound, and safe workplace management practices at all facilities. Under this strategic goal, critical outcomes are defined for BNL that require improvements in ES&H performance by the year 2000, including a quantitative 50 percent reduction in key metrics. Examples of critical outcomes include:

- Reducing the lost workday case rates to 1.3 cases per 200,000 work hours (50 percent of the 1995 rate of 2.6 cases per 200,000 work hours)
- Reducing environmental emissions to 50 percent of the 1995 value.

The BHG Business Plan has effectively linked these critical outcomes, as well as additional ES&H metrics performance in areas such as collective radiation exposure and average radiation worker exposure, to the AUI contract.

These initiatives have had some positive effects. For example, the worker safety goals have contributed to an increased level of management attention to accident and injury rates; the injury and illness data indicate a general trend toward lower accident and injury rates at most BNL facilities. However, as discussed under Guiding Principle #2, DOE's mechanisms to hold AUI and BNL accountable for meeting performance expectations are not effective.

CH has proactively embraced DOE management initiatives. For example, CH's transition in ES&H roles, from primarily line management oversight to primarily support to BHG, has empowered the BHG manager and his organization to be responsible for BNL performance and safety management of the site, reduced the number of layers in the CH organization, and facilitated coordination between BHG and CH.

Brookhaven Group (BHG) and BNL have a number of initiatives under way to improve ES&H performance.

BNL has launched a number of initiatives within the past two years, intended to improve safety management and performance. BNL and BHG, over the last year, have made major efforts to improve the outreach to stakeholders, including regulators, legislators, and the community. As a result, stakeholders have had additional opportunities to provide BNL and DOE with input and feedback related to safety policies, performance, and priorities. In 1996, BNL implemented a revitalization initiative designed to overcome complacency and renew interest in ES&H policies and performance across the Laboratory. The revitalization initiative included a series of facility operational stand downs, ES&H meetings, management discussions, and additional ES&H training sessions. Although problems remain, BNL has also taken steps to institutionalize safety policy and standards across the site through the ES&H Manual, which describes the BNL safety management system and defines high-level expectations for ES&H, and the Safety and Environmental Administrative Policy and Procedures Manual (SEAPPM), which describes how the high-level expectations are to be implemented sitewide. This effort is a positive initial step and, if further developed and implemented, could provide the framework for an effective safety management system at BNL.

Continuing weaknesses in management systems impede implementation of these initiatives.

While these important activities and initiatives have the potential to improve safety management at BNL, continuing weaknesses in DOE and BNL management systems impede implementation of these initiatives and degrade the effectiveness of safety management systems and ES&H programs. The most significant weaknesses include inadequate mechanisms to ensure accountability for performance and to achieve a reasonable balance between ES&H and mission-related priorities, and are discussed under Guiding Principles #2 and #4, respectively. DOE effectiveness in monitoring BNL ES&H performance has been very limited. This has included a failure to identify and resolve weaknesses in key ES&H programs, such as groundwater monitoring and radiation protection, as well as essential management systems and processes, such as issues management, work planning and control, and ES&H training and retraining. This weakness is at least partly attributable to DOE Headquarters direction, under the auspices of contract reform, to decrease direct DOE oversight of contractor operations and performance, and increase reliance on performance metrics.

Performance metrics are only one part of effective DOE line management oversight.

ES&H performance metrics can provide valuable performance feedback, and are especially effective when linked to the operating contract. Performance metrics alone, however, are not sufficient to monitor the day-to-day ES&H performance of contractors and need to be supplemented by direct line management oversight. This oversight, which need not be intrusive or burdensome, can take a number of effective forms. Examples include participation by DOE in key decisions related to ES&H, management walkthroughs and performance observations, strengthened facility representative and surveillance representative programs, systematic assessments of management systems and ES&H programs, and the ongoing analysis of performance data, including occurrence reports and trends. A trust-but-verify approach to line management oversight of contractor performance is in keeping with DOE's ultimate responsibility for the safe operation of BNL.

Within BNL, weaknesses in communicating ES&H policies and goals and translating them into site- and facility-specific procedures are evident throughout the organization. While some policies and goals have been communicated from DOE to AUI and BNL through contractual measures, ES&H goals have not been effectively communicated or stressed within AUI and BNL at the institutional level. For example, the AUI Policy Manual does not adequately convey expectations for integrating ES&H safety management systems into the operations and research missions, and it addresses ES&H policy only in the context of regulatory compliance.

Stop-work authority and measures to enforce subcontractor compliance with safety requirements are not effectively established.

Additionally, there are no institutional policies or procedures covering stop-work authority and no measures available to effectively enforce subcontractor adherence to safety requirements. Further, BNL has not been diligent in keeping important sitewide policies and procedures current, such as the ES&H Manual and SEAPPM, or in ensuring adherence to these requirements. The important step of translating these site documents to division- or department-specific versions has not been effectively implemented. Some department- or division SEAPPMs and other such documents are not current or complete.

DOE and BNL managers have not been aggressive in monitoring and followup.

CH, BHG, and BNL senior managers are not sufficiently engaged in monitoring and followup to assure that ES&H policies, programs, requirements, and commitments are understood, accepted, and implemented at every level. An absence of management field presence, insufficient communications up and down within line management, and weaknesses in line management oversight and assessments all contribute to the lack of effective engagement in safety management and management cognizance of actual ES&H performance. For example, senior managers at the site are not performing twice weekly walkthroughs of reactor facilities and regular walkthroughs of major energy research facilities as defined in management agreements between CH and NE and ER. Additionally, BNL lower-level managers and workers report that senior levels of BNL line management do not spend time in the facilities and are not proactive in supporting or emphasizing ES&H.

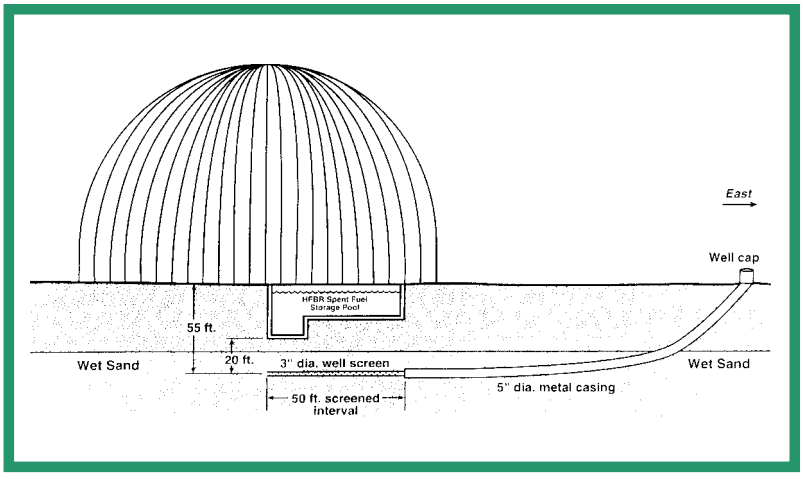
Strong leadership and direction for ES&H have not been evident.

CH, BHG, and BNL senior managers do not demonstrate the strong leadership and direction needed to attain stated ES&H goals or to ensure that appropriate safety management systems are established, implemented, and maintained. CH and BNL tend to delegate authorities and associated responsibilities for setting priorities, making decisions, and meeting requirements and commitments downward through their organizations. The ultimate responsibility for these activities cannot be delegated, however.

To implement their ES&H responsibilities, senior managers must have effective management systems, infrastructure, and communications in place to ensure that they remain aware of ES&H performance and key decisions, such as the delays in installing monitoring wells in 1992 and again in 1995. In general, CH and BNL managers have not developed effective mechanisms or practices to verify that their subordinates take appropriate actions, conduct activities safely, and make informed and appropriate decisions. Similarly, most subordinates have not been proactive in reporting back to their managers and supervisors on these issues. Managers have not devoted sufficient attention to followup and communications to ensure that goals and expectations are met.

The impact of these weaknesses in safety management systems and management's lack of involvement in safety are reflected in the chronology associated with the HFBR tritium plume:

Horizontal Well for Sampling Groundwater at the High Flux Beam Reactor



Horizontal Drilling To Detect Contamination beneath the Fuel Pool at the High Flux Beam Reactor

■ **Management systems were not effective in communicating the potential for and risk associated with a release from the HFBR to the groundwater**.

- In 1986, potable supply Well #1, south of the HFBR, was found to contain volatile organic compounds and tritium at levels higher than previously noted. The well was closed due to the levels of volatile organic compounds, but the source of the tritium was not pursued by management.
- A BNL engineering analysis of a 1992 Nuclear Regulatory Commission Information Notice indicated a need for three to five monitoring wells down gradient of the HFBR (i.e., south of the HFBR; and the direction of the groundwater flow is to the south). These wells were not installed, and the responsibility and the basis for this management decision cannot be ascertained. Documentation is not available to support this decision.
- In 1993, the EH Spent Fuel Vulnerability report noted that leakage from the unlined HFBR fuel canal could go undetected. Based on input from the site, that report incorrectly indicated that the fuel canal was being monitored for leakage through groundwater monitoring wells. BHG and BNL management did not challenge this conclusion or take action to install monitoring wells.
- In 1995, as a result of a seal failure on a primary coolant pump in the HFBR, water containing very high levels of tritium was released into the reactor building equipment space. Although some primary coolant could not be accounted for, site management did not take action to determine whether this primary coolant could have leaked into the groundwater, nor did they assess the deteriorating condition of floor seal material.
- In 1995, the tritium levels within the fuel canal increased significantly, but the source was never investigated or determined; management did not take actions to reduce the tritium levels and address the potential increased threat to groundwater.

■ **Managers were not effectively engaged in the processes for ensuring environmental regulatory compliance**.

- In 1994, BNL made a commitment to the Suffolk County Department of Health Services under Article 12 of their sanitary code (which covers storage tanks containing hazardous materials) to install two monitoring wells south of the HFBR, but did not follow through.

- In 1995, BNL made a decision to delay installation of the HFBR monitoring wells because of funding reductions; BNL did not adequately consider the commitment to Suffolk County in the decision process.

This chronology illustrates that CH, BHG, and BNL initiatives cannot be effective until their management systems are improved. Needed improvements include increased BHG and BNL senior management engagement and followup, and more rigorous management communications up and down the line. Further, it is imperative that the highest levels of management within BHG and BNL understand that while authorities may be delegated to subordinates, senior managers retain ultimate responsibility and accountability for priorities, decisions, and commitments.

More effective DOE line management oversight and leadership in ES&H is needed.

In summary, DOE and BNL need to improve line management performance in assuring the protection of the public, the workers, and the environment at the Laboratory. DOE needs to strengthen its line management oversight of contractor ES&H performance, including management systems and key ES&H programs. BNL needs to substantially increase management leadership and followup to assure understanding and sustained implementation of ES&H policies, programs, and instructions at every level within the organization. Within BNL, leadership must begin at the Laboratory Director level with demonstrated acceptance of the need for a change in safety culture and a mandate that ES&H will be an integral part of every site activity.

Clear Roles and Responsibilities

GUIDING PRINCIPLE #2: Clear lines of authority and responsibility for ensuring safety shall be established and maintained at all organizational levels within the department and its contractors.

Roles and responsibilities are not clearly defined at the DOE Headquarters level.

The roles, responsibilities, and authorities for assuring protection of workers and the environment in the operation of BNL for DOE Headquarters programs (ER, NE, EM), CH, and BHG are not clear. The roles and responsibilities of the Office of Field Management in safety management also appear to be a point of confusion within line management. Strategic realignment within the Department has shifted many responsibilities and authorities to the field offices. While this has the positive effect of empowering field office managers, it has also resulted in some level of confusion among Headquarters managers as to their remaining roles and responsibilities. Considering that BNL is a multi-program laboratory, with NE, EM, and ER having major roles, there is additional opportunity for confusion in the form of differing policy, direction, priorities, and allocation of funding for ES&H programs and activities. Improved coordination between those program offices is essential to assure consistent and effective sitewide safety management and the most efficient application of decreasing resources and funding.

Direction from multiple DOE program offices is also a source of confusion with facility and sitewide environmental monitoring and infrastructure upkeep. The “stovepiping” of responsibilities makes it difficult to define interfaces and manage emerging priorities. For example, it is not clear among ER, EM, and NE whether the installation of the groundwater monitoring wells at HFBR was a landlord environmental compliance responsibility or a facility operational responsibility. In addition, ER and EM have not determined how the overall approach to groundwater protection surveillance monitoring is to be coordinated with environmental restoration groundwater monitoring. This lack of clarity in roles and responsibilities is reflected at the site level as a contributing factor in the failure to install monitoring wells at the HFBR on a more timely basis.

Management agreements between CH and DOE Headquarters program offices, and correspondence between CH and BHG, loosely define responsibilities associated with management and oversight of sitewide operations. Despite recent CH initiatives to respond to DOE Policy 411.1, *Safety Management Functions, Responsibilities, and Authorities Policy,* expectations for ES&H performance remain neither clearly defined nor effectively communicated and recognized by site personnel. Ambiguity in roles,

Aerial View Showing Relativistic Heavy Ion Collider (top), High Flux Beam Reactor (middle right), Alternating Gradient Synchrotron (just left of center), National Synchrotron Light Source (middle right), and Chemistry (center)

responsibilities, and related channels of communication among DOE organizations (ER, EM, NE, CH, and BHG), and weaknesses in sitewide systems for accountability contributed to the multiple delays at the site level in installing monitoring wells at HFBR. The Headquarters program offices have recognized that ER and EM have historically not been sufficiently involved in decisions being made by NE, EH, CH, and BHG associated with the management review and approval of the tritium plume investigation and remediation. The approach to key decisions at BNL related to the tritium plume has been revised to ensure involvement by all DOE organizations with a vested interest in the decisions.

Responsibility and accountability for ES&H decisions made at BNL are not clearly defined.

Clear delineation of roles, responsibilities, and authorities, and documentation of the justification for decisions are important to ensure that decisions and actions occur at the proper management level, that BHG and BNL senior management are cognizant of these decisions and actions, and that the interests of DOE, BNL, and stakeholders are adequately addressed. In evaluating the chronology associated with the HFBR tritium plume and associated groundwater monitoring, the Oversight team had extreme difficulty in identifying the sources and bases for key decisions delaying installation and monitoring of the wells. Weaknesses and deficiencies in BHG and BNL management systems and processes for identifying roles, responsibilities, and authorities make it difficult to trace ownership for specific decisions. Exacerbating this issue is the fact that many decisions at BNL appear to result from consensus within a large number of committees; no single manager assumes responsibility (i.e., no single-point accountability), and the bases for decisions are not documented.

BHG has been empowered to direct and monitor BNL ES&H performance.

CH delegated authority to BHG for site management and oversight and thus invested BHG with responsibility for direction and line management oversight of BNL ES&H performance. However, this transition could have benefited from better planning and coordination to ensure smooth implementation by BHG. CH retains ultimate responsibility and accountability for ES&H performance at its laboratories, but no longer conducts assessments at the laboratories, relying instead on limited performance metrics and feedback from BHG.

However, BHG does not have sufficient staff, the requisite technical skill mix, or the necessary infrastructure to monitor BNL ES&H performance or provide timely and accurate feedback to CH on BNL ES&H performance.

Most notable is the lack of mechanisms to ensure that BHG staff understand, implement, and are accountable for their assigned ES&H duties. There are also significant weaknesses in BHG line management oversight practices, which are not structured, comprehensive, or sufficient to effectively assess the BNL weaknesses in safety management and work controls identified in this Oversight evaluation. The only current systematic line management oversight activity conducted by BHG is the facility representative program—facility representatives are assigned to nuclear facilities. Surveillance representatives are assigned to non-nuclear facilities. However, management has not ensured that surveillance representative expectations for conducting performance-based line management oversight have been communicated and understood. Further, position descriptions and individual development plans are not current.

Improvement goals have been defined in such areas as environmental emissions, total radiation exposure, and lost workday rates.

In 1995, DOE's contract reform initiative afforded CH and BHG the opportunity to modify the AUI agreement to establish performance-based metrics reflecting ES&H objectives. Improvement goals in key areas, such as reducing environmental emissions, lost workday rates, and total radiation exposures, were incorporated into the contract. During the same time period (1995-1996), BHG received direction from DOE Headquarters and CH to increase reliance on performance metrics and reduce direct DOE line management oversight of contractor performance. This direction was in part a response to complaints by DOE laboratories and advisory groups that DOE oversight has historically been extraordinarily intrusive and burdensome. Accordingly, DOE has taken many actions to reduce excessive oversight, including contract reform, the pilot oversight program, and consolidation of previously-fragmented DOE Headquarters ES&H oversight into a single consolidated EH independent oversight program. Notwithstanding these efforts, it is impractical, if not impossible, to effectively monitor ES&H performance through quantitative metrics alone. Such measures must be supplemented by analyses of feedback from many sources, including operating events and trends, DOE assessments, BNL self-assessments, management walkthroughs, and worker input.

Experience with contractual performance measures suggests that DOE may be over-emphasizing the incorporation of ES&H expectations into metrics.

The contract negotiated in 1995 effectively communicates explicit ES&H performance expectations to BNL, to the extent that performance can be captured by metrics. However, the contract does not contain adequate incentives and penalties to promote accountability in a not-for-profit setting. Although BHG was empowered to oversee BNL safety performance, the absence of meaningful contractual provisions related to ES&H measures is a significant barrier to safety management. For example, only 7.5 percent of BNL's performance evaluation criteria, which are used to determine annual performance ratings, are related to ES&H. In addition, DOE experience with contractual performance measures over the past two years strongly suggests that DOE may be overemphasizing the incorporation of ES&H expectations into metrics. Some operational matters, including ES&H management, might be better addressed as qualitative contract requirements, rather than as quantitative performance measures.

Weaknesses in accountability limit the effectiveness of the BNL program.

BNL has initiated some positive actions to institutionalize roles and responsibilities for safety management, including division- and department-specific implementing documents developed in response to the sitewide Laboratory Standards and the Safety and Environmental Administrative Policy and Procedures Manual (SEAPPM). However, some of these documents are cursory, are not rigorously maintained, and are incomplete. In addition, senior

National Synchrotron Light Source with High Flux Beam Reactor in Background

BNL managers have not taken steps to ensure that these implementing documents meet the sitewide objectives, such as accurately reflecting site standards and contractual ES&H requirements. Weaknesses in mechanisms to ensure individual accountability for managers helps foster these deficiencies. These weaknesses include:

- Measurable ES&H performance elements are not incorporated into BNL managers' annual performance appraisals.
- ES&H roles, responsibilities, and accountability are not clearly delineated to support individual managers' accountability.
- An effective system of rewards and penalties linked to management ES&H performance and annual appraisals has not been established.
- Some senior BNL line managers are focusing almost exclusively on scientific programs and are not being held accountable for ES&H.
- BNL has not established effective institutional processes to ensure that managers understand, demonstrate commitment to, and effectively implement their ES&H responsibilities, including correction of identified deficiencies.

There is currently no effective policy for applying sanctions to subcontractors for ES&H non-compliance.

Subcontractors to BNL carry out many activities at the site, such as construction and environmental restoration. There is currently no policy for applying sanctions to subcontractors for non-compliance with ES&H requirements. Terminating the contract for cause and barring specific individuals from site access are the principal sanctions available. However, enforcement is ineffective, as there are opportunities for poor ES&H performers to obtain site access and employment under alternative contract vehicles. BNL has recently modified its procurement procedures to consider subcontractors' safety performance as well as cost, which is a positive step toward achieving improved ES&H performance and accountability. However, BNL recognizes that additional strengthening of accountability mechanisms for subcontractors performing work on site is needed, including quantitative ES&H performance measurements, specific requirements in contracts, and financial penalties for non-performance.

BNL does not have effective processes for ensuring that visiting facility users are indoctrinated and trained on ES&H policies and facility hazards.

BNL facilities are used by researchers from universities (faculty and students) and from private industry (about 4000 such users per year). These facility users represent a large, transient, and continuous flow of individuals who may be unfamiliar with and unaccustomed to DOE requirements and safety practices. In some instances, visiting scientists have implemented effective safety practices brought from their sponsoring organizations or from their previous experience. User

responsibilities for safety and potential facility hazards are defined at varying levels of specificity and formality in different facilities. However, there is no effective institutional process for ensuring that visiting BNL facility users are effectively indoctrinated and trained on safety policies and requirements and potential hazards that they may encounter. In addition, BNL line management oversight to ensure implementation of sound ES&H practices and accountability for facility users is lacking.

ES&H responsibilities and accountabilities need clarification throughout DOE line management and within BNL.

In summary, the establishment of clear lines of authority and responsibility and management systems and mechanisms for achieving accountability for ES&H is a significant weakness and warrants immediate management attention. DOE needs to clarify Headquarters roles, responsibilities, and authorities and to improve coordination between the program offices in providing policy and direction as well as the allocation of resources. Accountability for ES&H performance needs to be substantially strengthened for DOE and BNL, including accountability for managers and accountability mechanisms within the AUI contract.

Competence Commensurate with Responsibility

GUIDING PRINCIPLE #3: Personnel shall possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.

BHG has a generally effective ES&H training and qualification program.

BHG managers and professional staff have sufficient technical competence and understanding of basic safety principles to manage the multiple, diverse missions and projects at the site. CH has demonstrated a proactive approach to enhancing competence by requiring that all BHG technical personnel complete and qualify for the general technical base and specific functional area standards developed to meet Defense Nuclear Facilities Safety Board Recommendation 93-3. In general, the BHG training and qualification program is well organized and effective. Although individual development plans are not current, managers are effective in ensuring that workers receive needed training. The BHG training program for facility representatives (nuclear facilities) is comprehensive and well structured. However, the corresponding training program for surveillance representatives (non-nuclear facilities) is less comprehensive and lacks a comparable level of structure and formality.

Since CH delegated additional authorities and responsibilities to BHG in 1996, BHG has continued to operate with deficiencies in its technical skill mix. There are recognized inadequacies in staffing for such areas as radiation protection and industrial safety and hygiene. BHG is currently recruiting to satisfy some of these needs. CH and BHG have recently conducted a formal staffing needs analysis to examine existing skill mix limitations. In the interim, BHG needs to better utilize existing CH resources for assessment activities.

BNL personnel's technical expertise is exemplified by its cutting-edge research.

BNL managers, supervisors, scientists, and staff generally have the appropriate educational background, technical knowledge, and experience necessary to carry out their assigned technical responsibilities. Their technical and scientific expertise is exemplified by the cutting-edge scientific and medical research performed at BNL. This scientific knowledge is further supplemented by the scientists, technicians, and experimenters from academia and industry who use the Laboratory's research facilities. Further, environmental protection and safety personnel within BNL's Safety and Environmental Department (S&EP) and Organization for Environmental Restoration, as well as operations professionals within HFBR, AGS, and NSLS, exhibit a high degree of professional competence.

BNL senior management is not aggressively pursuing a comprehensive approach to fostering

ES&H competence in all elements of the workforce. The greatest training effort has been applied to the Reactor Division and the new Hazardous Waste Management Facility training programs. These training programs are relatively strong, and both are consistent with commercial nuclear industry standards. However, there are deficiencies in ES&H training programs in other departments and divisions, contributing to weaknesses in work planning and control at BNL.

For example, this safety management evaluation determined that 7 of 26 Facility Safety and Support (FSS) technicians had not been qualified to perform radiological protection work in accordance with Code of Federal Regulations requirements for occupational radiation protection (10 CFR 835). In at least one event, insufficient FSS technician competence may have contributed to selection of inappropriate equipment for monitoring radiation dose and workers receiving a collective dose that was more than three times the estimate for the work. The unqualified technicians were placed on administrative duties following identification of this issue by EH.

Previously identified weaknesses in radiological control have not been corrected.

Inadequate qualifications of radiological control technicians had been identified in 1993 by an external assessment and was never satisfactorily corrected. Further, FSS technicians are responsible for industrial safety and hygiene and hazard analysis and controls, but many lack training in these areas. Many other BNL personnel with important ES&H responsibilities, including ES&H coordinators and experiment principal investigators, do not have sufficient formal training and experience in ES&H. According to BNL assessments, BNL workers receive only an average of 3.2 hours of ES&H training annually, and researchers, who typically have the least ES&H experience, receive less then two hours annually. This is not sufficient to communicate and ensure understanding of ES&H policies, requirements, and procedures and to ensure understanding of BNL radiological, chemical, and industrial hazards.

The BNL training programs are not effectively designed and implemented.

Specific weaknesses in sitewide training programs include inconsistent use of standard instructional design and implementation practices, minimal student course evaluations, nonexistent instructor qualification programs at several facilities and support groups, minimal and infrequent refresher training, informal lesson plans and course objectives, and examinations that are not challenging. Further, there is no central training and qualification database to ensure that only qualified individuals are assigned to potentially hazardous work. Weaknesses were also observed in the structure, duration, and effectiveness of training on ES&H hazards, policies, requirements, and procedures for BNL managers and staff, research facility users, and subcontractors.

At one facility, workers with outdated training performed work on energized equipment, without procedures or adequate safety equipment.

The minimal ES&H training and deficiencies in experience are reflected in the informal approach to controlling work and related hazards at BNL non-reactor facilities. Potentially hazardous work is often accomplished on the basis of verbal direction from supervisors, with overreliance on the ES&H competencies of the supervisor and workers. For example, the EH team observed an event at the National Synchrotron Light Source, where Plant Engineering assigned electrical workers to perform "hot" work (i.e., work near energized electrical equipment). In this instance, the workers' hot work and electrical safety training qualifications had expired, and the workers performed work on energized equipment without procedures and without adequate safety equipment. Further, when notified of this situation, several BNL personnel failed to take appropriate action to stop the work. This event suggests that safe conduct of work at BNL is primarily dependent on the expertise and judgment of the personnel performing the work. This dependence is not always justified, especially in light of the weaknesses in ES&H training and structured work planning and hazard controls.

The National Synchrotron Light Source Facility

Worker involvement in hazards analysis, work planning, and procedures is not solicited.

Hazards analysis begins with an understanding of the work and the course of action necessary to accomplish it—worker involvement in hazards analysis and work planning is therefore essential. Active participation in the initial stages of work planning also helps ensure that workers understand the hazards involved and "buy in" to the identified controls. Workers at BNL are typically not empowered or encouraged to participate in job hazards analysis, work planning, and the development of safety policies and procedures. Workers and subcontractors indicated that they would not hesitate to stop their own work and notify a supervisor if a safety issue arose, but expressed reluctance to stop the work of others and were generally not aware of any process or procedure for doing so.

Workers appear willing to report safety concerns.

Many BNL workers believe they can resolve most safety issues by discussion with their immediate supervisors. For situations that are not immediately resolvable, workers can and do use several avenues to voice ES&H concerns, such as union stewards and safety officers, ES&H coordinators, a BNL hotline, the Labor Grievance Committee, and employee concerns programs. Some weaknesses were noted in the BHG and BNL employee concerns programs. Most notably, these programs were not well advertised or promoted, and there were no appropriate performance metrics to measure employee satisfaction and awareness. However, interviews conducted during the integrated safety management evaluation indicate that workers would not hesitate to report a safety concern if it could not be resolved satisfactorily by their supervisors.

Senior management commitment to training needs to be strengthened to ensure that experienced and capable staff are provided the needed ES&H training.

BHG and BNL have many highly educated, experienced, and qualified individuals within their organizations. While many BNL managers and personnel have very little formal training or experience in ES&H, they have considerable scientific background and experience, and are capable of identifying and controlling work hazards in most cases. This is particularly true in reactor and accelerator operations and large scale experiments.

In summary, the level of competence within the DOE organizations responsible for the Laboratory and BNL, including experience, knowledge, and skills, is considered appropriate and effective. In the absence of institutionalized processes for hazard analysis and work controls, it is the high level of scientific and technical expertise that is helping to assure safety in hazardous site operations. Specific improvement, however, is warranted in areas such as ES&H training for staff and visitors, technical staffing and skill mix within BHG, and the training and qualification of FSS technicians (radiation protection and industrial safety and hygiene).

Balanced Priorities

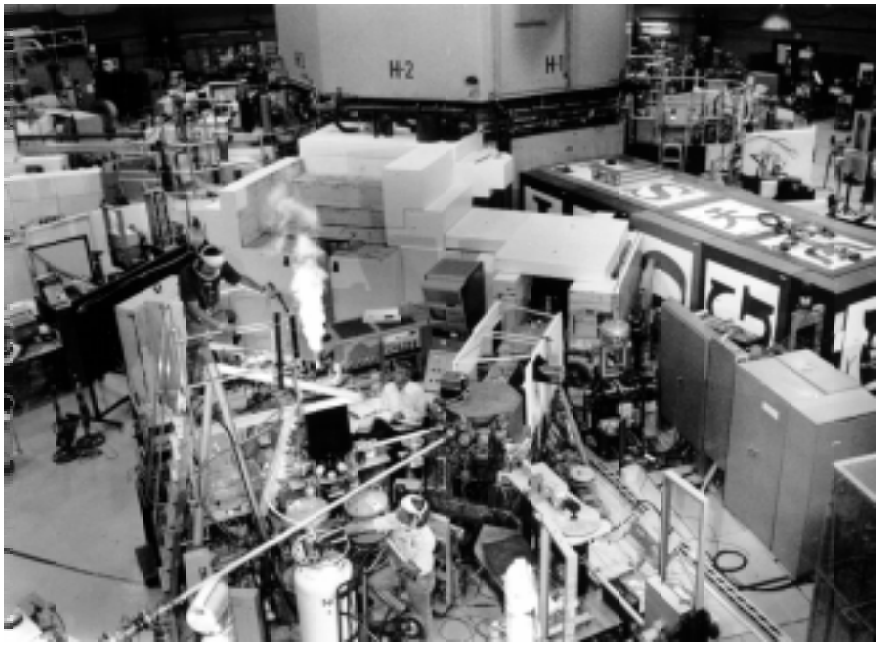
GUIDING PRINCIPLE #4: Resources shall be effectively allocated to address safety, programmatic, and operational considerations. Protecting the public, the workers, and the environment shall be a priority whenever activities are planned and performed.

Initiatives and programs have had positive impacts on ES&H in some instances, but tend to be reactive.

In a number of instances, DOE Headquarters and CH have demonstrated support for ES&H programs at BNL. EM has sponsored waste minimization projects, such as the waste compactor at the AGS, and unanticipated remedial actions, such as providing for offsite residential public water hookup. CH and BHG initiated contract reform to incorporate ES&H performance metrics into the AUI contract in 1995. CH, BHG, and BNL also established aggressive ES&H improvement goals in such areas as reducing site emissions, lost workdays, and radiological exposures. BNL has strengthened ES&H at the reactors by focusing on improving experimental safety and conduct of operations, and recruiting personnel with military and commercial nuclear experience

However, although management has embraced these enhancements, most were reactive and initially driven by events or external interest (e.g., Superfund, the TRISTAN fire, and more recently public concerns over the tritium contamination issue). Accordingly, CH and BHG resources for ES&H assessments tend to be allocated in response to specific concerns rather than as part of a systematic, rigorous, and proactive program. In general, ES&H issues are not effectively integrated into information flow, decision-making processes, or mission objectives at BNL.

Funding for BNL programs is allocated principally according to the programmatic needs of several Headquarters offices—EM, ER, and NE. Landlord responsibility for all Laboratory facilities belongs to ER. EM provides programmatic direction and funding for environmental restoration and waste management, while NE provides direction for operation of the two reactors.



1993 Photo of HFBR Experimental Floor Showing TRISTAN Experiment (TRISTAN Now Removed)

Allocated resources are not always commensurate with hazards.

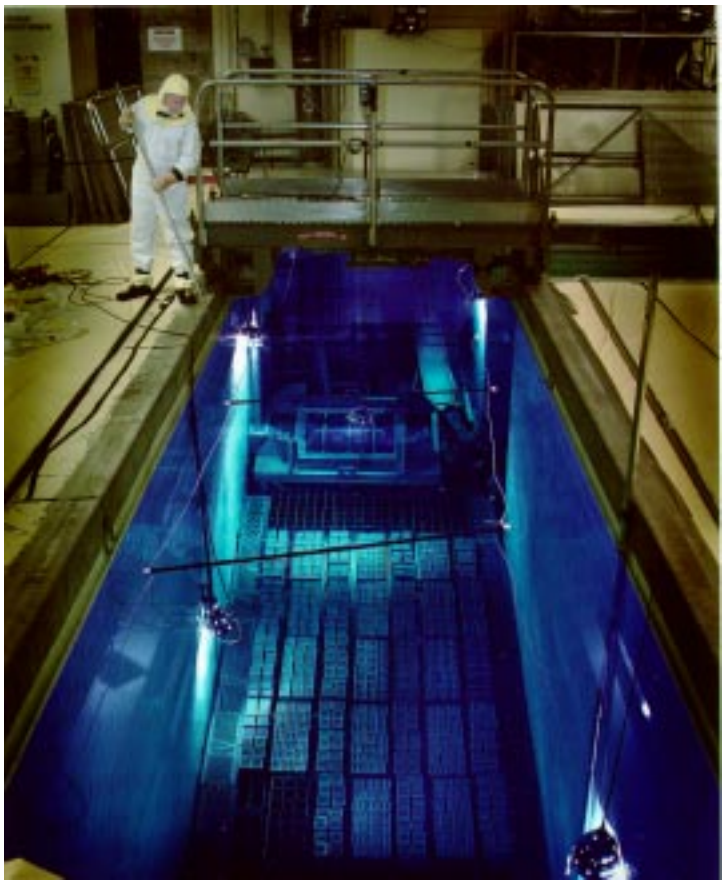
Under this multi-program arrangement, ES&H infrastructure requirements, such as routine groundwater monitoring, maintenance, fire protection, and facility and system upgrades, are funded through contributions from the various program offices. As the site landlord, ER funds support its programs and ES&H infrastructure needs throughout the site (i.e., ER funds are not used solely to support its programmatic requirements). Conversely, funds contributed by EM are earmarked for its programs only. ES&H infrastructure and projects are often funded out of overhead accounts at BNL. During a time of continual reduction in overhead funding, ES&H is in direct competition with mission activities and projects funded from the same source. At BNL, there are indications that ES&H needs are not given appropriate priority in the competition for resources. The imbalance in the competition for available funding is evident by the five-year delay in installing groundwater monitoring at HFBR. The impact can also be seen in a similar five-year delay in funding and implementing the upgrade of the HFBR safety analysis report to meet DOE order requirements.

As resources available to ER for general infrastructure improvements decline (i.e., reductions in allocations for the Multi-program Energy Laboratory/Facility Support Program), there will be increased pressure to fulfill ES&H improvements using direct funds which are primarily dedicated to research programs. As a result, reduction in the current backlog of $150 million at BNL associated with aging facility and utility upgrades and equipment maintenance could be negatively impacted.

Allocation of funds that are directly tied to a specific program are not necessarily commensurate with known hazards or most important ES&H sitewide issues. For example, environmental restoration funding from the EM budget in support of groundwater monitoring and cleanup near HFBR was not available to support monitoring of operating facilities. Programmatic funding for environmental compliance of HFBR is the responsibility of NE, funded through ER. In addition, ER is responsible for sitewide groundwater protection and monitoring to ensure worker, public, and environmental compliance associated with all other operating facilities and utilities. It is not clear that EM, ER, and NE recognize or address these programmatic and budgetary interfaces from a sitewide perspective.

In an effort to appropriately balance mission-related priorities with ES&H needs, BNL applies the DOE ES&H Management Plan prioritization process to plan major projects and capital improvements. This Plan provides guidance for setting ES&H priorities for funding requests and promotes use of a structured process across the DOE complex. In the prioritization process, specific ES&H projects and activities are scored according to assessed level of risk. The risk ranking is carried out according to judgment based on several elements, including the proposed activity's potential impact on public safety and health, site personnel safety and health, compliance with regulatory requirements, mission impact, and environmental protection.

HFBR Spent Fuel Canal



The risk ranking score for HFBR monitoring wells did not consider important information.

While this process can be an effective planning tool for establishing relative risk rankings and priorities, the end product (i.e., the actual ranking) is only as good as the input to the risk ranking process and is dependent on the judgment of those applying the model. When the need to install monitoring wells downgradient of HFBR was identified in 1992, and then again in 1995, a number of key factors were apparently not considered in the risk ranking process:

- Elevated tritium levels detected in an onsite production well south of HFBR in 1986
- A 1995 primary coolant pump seal failure that released heavy water onto the reactor floor; the event analysis failed to account for all water released, the deteriorating condition of floor penetration seal material, and the potential environmental impact
- Elevated tritium levels noted in the fuel canal beginning in 1995
- A 1994 regulatory compliance commitment to install monitoring of the HFBR spent fuel canal that was made by BNL to the Suffolk County Department of Health Services under Article 12 of the Suffolk County sanitary code, which delineates requirements for structures such as the spent fuel canal; the risk ranking score did not include consideration of the compliance weighting factor
- Stakeholder and public concerns and sensitivity to protecting the sole source aquifer under the site.

The installation of the HFBR wells scored only 25 points in a risk ranking system where there is minimal consideration for special funding of activities that have a score of 75 or less. The decision to delay the installation of the wells in 1995, despite the commitment to Suffolk County, was based primarily on reductions in funding to the special maintenance (overhead) budget.

CH has recognized concerns in the application and use of the risk-based prioritization model within their laboratories. In its report entitled *CH Environmental, Safety and Health Management Plan Facilities Summary and Fiscal Year 1998 Unicall Information Request*, CH indicated that the risk model in being misapplied (at some CH laboratories) and that risk scores are being consistently deflated. The model includes a factor that considers the likelihood of noncompliance with laws and regulations; sites have applied that factor as the likelihood of regulatory discovery.

BHG personnel have had limited involvement in the resource allocation process.

Compounding this weakness is the limited participation by BHG staff on the Risk Ranking Committee, and limited management involvement in reviewing budgetary requests for activities that fall below the funding cutoff level. Accordingly, BHG's knowledge of the resource allocation process remains limited, impacting their ability to influence BNL risk prioritization and resource allocation determinations. These weaknesses were recognized in a recent CH assessment of BHG.

An appropriate balance between ES&H needs and operational considerations must be applied to all potentially hazardous activities, including operations, maintenance, and research. There is a perceived competition, particularly at some research laboratories, between creativity and freedom essential to scientific inquiry and the level of discipline necessary to control hazards and assure safety to the public, workers, and the environment. At BNL, there is informality and lack of structure and adherence to standards in controlling some research, operational, and maintenance activities. Heavy reliance is placed on the experience and competence of managers, supervisors, and individuals to identify and control potential hazards in the workplace. The desire for freedom of research, along with the general lack of ES&H experience and training (particularly outside of the reactor areas), contributes little to ensure the desired balance in priorities. This informal approach may fail to appropriately recognize and respond to ES&H hazards and considerations.

A number of cultural and operational factors may exacerbate a tendency to undervalue ES&H priorities in the absence of an institutionalized hazards analysis and work planning process:

- Variable ES&H experience among research facility users and subcontractors
- Funding reductions in overhead, support functions, and general plant projects, which disproportionately affect ES&H activities
- Pressures resulting from schedule commitments and a desire to maintain reactor and accelerator availability to support research and experimental efforts
- An absence of guidelines for using a graded approach in applying ES&H requirements and policies, thus creating the potential for inappropriate exemptions
- Some managers who do not provide sufficient support for ES&H needs in allocating resources or control of work.

Management has not demonstrated the level of ES&H support needed to make ES&H an integral part of BNL priority setting and work planning.

Achieving balanced priorities between mission accomplishment and sound ES&H management must flow from senior management leadership. Beginning at the highest levels, management must demonstrate a commitment to ES&H by insisting that effective work planning, hazards analysis, and hazard control be an integral part of every potentially hazardous activity on site, including operations, research, maintenance, and environmental restoration. Leadership must also be demonstrated through prioritization and prompt resolution of safety issues, funding of maintenance and upgrades to systems and equipment, and support for ES&H training. The level of ES&H support needed to achieve balanced priorities has not yet been consistently demonstrated by senior managers and their subordinates at BNL.

DOE and BNL management need to apply appropriate criteria and judgment in risk ranking.

In summary, DOE Headquarters, CH, BHG, and BNL have made an effort to strengthen safety management and achieve balanced priorities by issuing safety practices, undertaking contract reform and aggressive ES&H improvement goals, and using the ES&H Management Plan prioritization process. Balancing the priorities of mission objectives and sound ES&H stewardship still remains a significant weakness warranting immediate management attention and action. Success will require a demonstrated commitment to making ES&H an integral part of every activity on the site by BNL senior management, beginning with the AUI corporate and the BNL Director. In addition to institutionalizing the ES&H program through training, procedures, work planning and control, and aggressive management involvement and accountability, DOE and BNL management need to ensure that appropriate criteria and judgment are used in applying relative risk ranking, and that management systems provide senior management the necessary information to allocate resources for ES&H programs, critical activities (including groundwater monitoring), and essential infrastructure and facility upgrades.

Case Study - Experimental Safety

On February 11, 1997, a Chemistry Department researcher engaged in a chromatography experiment using a potent allergin became ill and reported mental confusion and balance problems, suggesting a possible chemical exposure.

- Chemistry Department policy delegates the determination of a need for hazard analysis to the principal investigator (normally a designated experimenter).
- Independent review (as required by the Safety and Environmental Administrative Policy and Procedures Manual) and/or experimental hazard (ES&H) evaluations were not performed.
- The potential health effects associated with this potent allergin had not been adequately analyzed or understood prior to the experiment.
- The experiment protocol specified personal protective equipment (gloves) that did not provide protection from the substance being handled.
- Descriptions of the chemical and its health effects were not readily available to the researcher as required.
- The draft version of BNL ES&H Standard 2.1.1, "Laboratory Chemical Hygiene Plan," contains instructions that might have prevented this incident, but the standard has not been approved or issued for more than a year.

Identification of Safety Standards and Requirements

GUIDING PRINCIPLE #5: Before work is performed, the associated hazards shall be evaluated and an agreed-upon set of safety standards shall be established that, if properly implemented, will provide adequate assurance that the public, the workers, and the environment are protected from adverse consequences.

CH and BHG have improved processes to identify requirements in the BNL contract.

Internal requirements, such as DOE orders, and external requirements, such as those from the Environmental Protection Agency (EPA), and state or local regulatory agencies, are identified by DOE and incorporated into the AUI contract. CH and BHG have made a number of improvements to the contractual incorporation of requirements in the past two years. For example, the current contract specifically identifies DOE orders and external requirements that AUI/BNL is contractually required to implement. Additionally, for selected requirements documents, such as revised DOE orders, DOE requires BNL to develop implementation plans and have them approved by BHG.

New requirements documents identified by DOE are channeled through the BNL Associate Director for Administration for distribution to site organizations for review, response, or implementation as appropriate. Monitoring of revisions to external requirements and the review and implementation of DOE-specified requirements are the responsibilities of technical specialists, primarily in S&EP (which is the BNL ES&H support organization), and are typically an informal process.

The BNL ES&H Manual sets forth sitewide ES&H policy and standards.

Typically, requirements are incorporated into BNL site-level documents, most notably the ES&H Manual and the Laboratory Safety and Environmental Administrative Policy and Procedures Manual (SEAPPM). The ES&H Manual sets forth the Laboratory ES&H policy and contains the Laboratory Standards for meeting ES&H requirements. The SEAPPM provides a set of formal implementing policies and procedures that can be utilized or adapted as appropriate by Laboratory departments and divisions. The Laboratory Standards and SEAPPM are intended to be implemented, as applicable, through facility-level policies and procedures, including department- and division-level SEAPPMs.

Figure 4 shows the intended flowdown of requirements at BNL. As discussed below, however, this process does not provide the benefits of DOE's

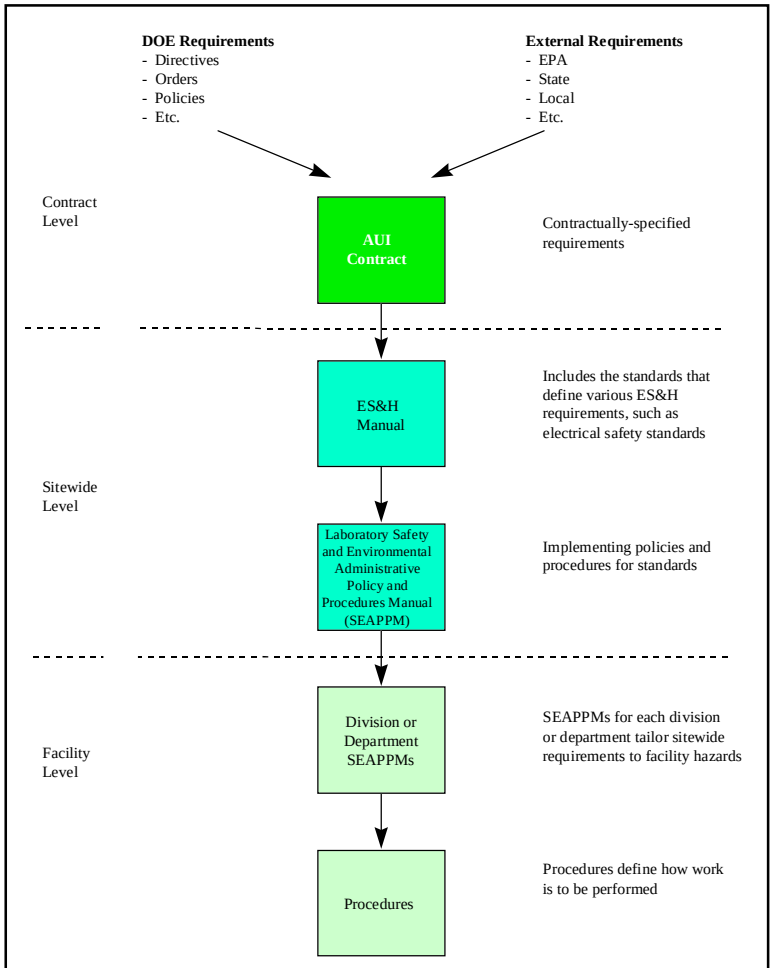


Figure 4. BNL Approach to Identification and Flowdown of Requirements

more systematic approaches to requirements, is not consistently effective, and is not implemented as intended in many cases.

There are a number of opportunities for improvement in the evaluation and implementation of ES&H requirements at BNL. Implementation plans prepared by BNL for new or revised DOE orders have, in some cases, taken credit for existing actions or processes that did not fully address the new requirements, and BHG reviews have not been rigorous in determining the adequacy or appropriateness of the specified implementing mechanisms. The implementation of some DOE orders related to safety analysis of reactors has not been timely or adequate, as discussed in more detail under Guiding Principle #7.

BNL does not have a Laboratory Standard for experimental reviews.

Although most personnel working at BNL are involved in experimental activities, there is no Laboratory Standard in the Laboratory ES&H Manual to govern experiment reviews. In the absence of such sitewide guidance, there is not sufficient assurance that DOE and BNL requirements and expectations are being effectively implemented for the wide range of experiments and associated hazards. In some cases, at the institutional level, the Laboratory Standards reflect outdated DOE orders and industry standards in areas such as laser safety and respiratory protection. In addition, the BNL SEAPPM has not been kept current to accurately reflect standards or the processes being applied at BNL in several areas, including assessments and radiological control.

Sitewide policies and procedures are not always adapted to specific facilities and activities.

At the department/division level, implementation of Laboratory Standards and application of the Laboratory SEAPPM have not always been effective. The Laboratory SEAPPM has not always been appropriately adapted and tailored to departmental application, resulting in conflicts between policy, procedures, and practices. For example, implementation of the Laboratory Standards for electrical safety and radiological control has been inconsistent and has resulted in performance deficiencies within some facilities and activities.

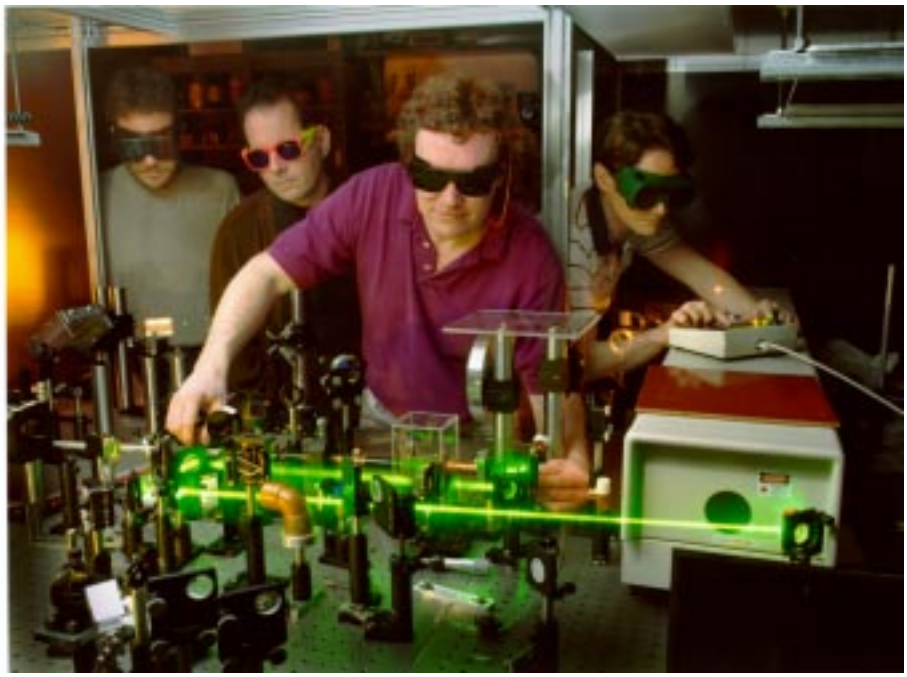
BHG has not implemented an effective line management oversight program.

Performance-based assessment activities provide management with information essential in determining whether ES&H requirements and policies are understood and implemented. While the 1995 contract established a number of ES&H performance metrics and goals, continuous, real-time DOE line management oversight and assessment of BNL ES&H performance is still necessary. Since 1995, the primary oversight roles and assessment responsibilities of CH have been delegated to BHG. CH's ES&H role is now primarily technical support, with technical assistance and assessment services provided only as requested by BHG.

BHG has not established and implemented a structured, effective oversight program sufficient to ensure that ES&H requirements are implemented. Current assessment activities are too infrequent, do not sufficiently focus on work activity performance, and do not address programmatic effectiveness or systemic issues (e.g., funding, hazard analysis and mitigation, work planning and control, issues management, and understanding and acceptance of ES&H policies and requirements). The level of line management oversight provided by the BHG surveillance representative program does not meet the intent of DOE orders relating to conduct of operations.

BNL has established a three-tier assessment program.

BNL has established elements of an assessment program capable of achieving continuous improvement in ES&H performance across the site. BNL has an established quality assurance (QA) program that includes audits of ES&H program elements, which are conducted by a Laboratory Quality Management Office and departmental QA representatives. A three-tier ES&H assessment program is structured as follows:



The Laser Lab at the Chemistry Department

- Tier I inspections are routine basic safety inspections. The Tier I safety inspections include workers, departmental and S&EP safety specialists, managers, and DOE representatives. Tier I inspections are formal and frequent, with findings formally tracked to resolution.
- The 1996 Tier II self-assessments are departmental appraisals of ES&H performance. Tier II assessments, formerly performed as independent appraisals by the S&EP Division, have the potential to increase line ownership of ES&H performance and foster the integration of safety management.
- Tier III assessments are independent programmatic appraisals of broad functional areas (such as environmental restoration, waste management, or radiological protection) performed by outside contractors chartered by AUI. Tier III appraisals are intended to serve a corporate oversight role.

Assessment and corrective action processes have not been effectively implemented.

However, implementation of these elements has not been fully effective. The BNL assessment and corrective action processes exhibit a number of functional weaknesses and have not been consistently effective in ensuring real change in ES&H performance. For example, Tier I safety inspections focus almost exclusively on facility material conditions, with little evaluation of work activities and ES&H performance. Inspection results are not analyzed for adverse trends, and although individual deficiencies are being corrected, measures to prevent recurrence need to be identified and implemented.

Tier II self-assessments have not yet been clearly defined to ensure that all functional areas are assessed on a periodic basis; that sitewide functional area performance is adequately addressed; that the process is consistently and rigorously implemented; and that findings, corrective actions, and measures to prevent recurrences are approved by management and placed into a tracking system. Corrective actions for findings from the Tier III appraisals have not been formally reviewed and accepted by AUI, nor has the progress to resolution been aggressively monitored. Timely and effective resolution of issues is essential to the success of a self-assessment program. Many QA audits of ES&H activities have not been performed as scheduled.

Analysis of deficiencies and corrective actions is not adequate.

Most identified ES&H deficiencies are not subjected to structured review or analysis to identify adverse trends and cross-cutting issues. The capture and tracking of corrective actions are incomplete and are not used as an effective management tool. Corrective actions have not always been completed as specified or in a timely manner.

Weaknesses were identified in the evaluation of ES&H deficiencies and in the adequacy of corrective actions for assessment findings and recordable occurrences. A number of instances were identified where root causes and recurrence controls were not appropriately identified. Many of the weaknesses and concerns identified in this integrated safety management evaluation and in recent BNL and BHG appraisals were identified in previous assessments and either remain as open items or were not effectively resolved prior to closure.

Senior management has not been aggressive in ensuring attention to ES&H requirements.

A number of elements necessary to effectively identify and implement requirements at BNL are in place and functioning. However, senior management has not been aggressively engaged in ensuring that ES&H requirements are clearly understood, accepted, and implemented. Improvement is needed in requirements implementation (implementation deficiencies are discussed in more detail in the field report which evaluates selected ES&H programs and BNL performance with respect to the core functions), validation of whether performance meets the requirements, and correction of performance deficiencies.

More management focus is needed in the maintenance of site standards and policies and in the translation of requirements into facility-specific implementing procedures and policies.

Both BHG and BNL need to strengthen their assessment programs to be more performance-based, including observation of ES&H performance in the field and analysis of performance data, occurrence reports, and trends. Management involvement is needed to ensure that ES&H deficiencies, including those identified by BNL and BHG assessments, are effectively evaluated and resolved in a timely manner, and that root causes and recurrence controls are identified and implemented.

Hazard Controls Tailored to Work Being Performed

GUIDING PRINCIPLE #6: Administrative and engineering controls to prevent and mitigate hazards shall be tailored to the work being performed and associated hazards.

Sitewide Hazard Analysis and Control

Various BNL programs at the institutional level provide direction and guidance for the development of administrative and engineering controls to prevent and mitigate hazards associated with the performance of site missions and work. A sitewide baseline hazards assessment was completed in 1996 in support of emergency planning. S&EP has performed a comprehensive review and annual upgrade of selected industrial hygiene programs and related hazards assessments across the site, including bloodborne pathogens, confined space entry, hazards communication, hazardous waste operations and emergency response, lead used in construction, noise and hearing conservation, and occupational exposure to hazardous chemicals in laboratories. S&EP also provides ES&H technical expertise to various facilities and programs at BNL. The Laboratory ES&H Manual identifies applicable standards and requirements applicable to the identification and control of hazards, while the SEAPPM provides policies and procedures for their implementation. The Laboratory Operations and Maintenance Manual delineates requirements for hazards identification and controls for related activities.

BNL has not established standards governing conduct of experiments.

BNL's approach to experimental safety relies on the researchers and safety review committees. These committees are intended to play a key role in the control and mitigation of hazards through the review and approval of proposed new experiments and significant experiment modifications. In general, these processes are effective for major experimental activities. The requirements for and the effectiveness of experimental safety reviews vary widely among

the facilities reviewed. Although there is a Laboratory SEAPPM describing experiment safety reviews, BNL has not established the Laboratory Standard to govern the conduct of experiments, including hazards analysis and control. Significant weaknesses in some activity-specific hazard analysis and control were identified, as discussed below.

Facility- and Activity-level Hazards Analysis and Control

Progress has been made in hazards analysis and control at the HFBR.

Over the last several years, HFBR personnel have made significant progress in managing work activities and the associated hazards analysis and control. The analysis and control of hazards associated with beam experiments (radiological, electrical, and chemical) and emergency planning and response have been strengthened as a result of actions taken after the TRISTAN experiment fire in 1994. Conduct of operations has also been strengthened through the application of DOE Order 5480.19, Conduct of Operations for DOE Facilities, and the recruiting of reactor managers and staff with military and commercial nuclear backgrounds. Reactor operations activities are accomplished through approved procedures, communications are formal, and most maintenance work is accomplished with an appropriate level of planning and control.

Hazard controls are effective for work directly related to operations and major modifications of reactors and accelerators.

Hazards analysis and controls are being applied effectively to operations and major modifications for work directly related to reactors and accelerators. Safety committee reviews at the Alternating Gradient Synchrotron (AGS) include walkdowns of all proposed experiments by the experimental review committee and appear to work well. The standing Experiment Review Team and the Reactor Safety Committee at the HFBR provide another example of effective hazard review. The Beamline Review Committee and the direct interaction and day-to-day oversight of operations coordinators provide hazard control mechanisms at National Synchrotron Light Source (NSLS).

Hazard control processes for bench-level experiments and maintenance are not adequately developed or implemented.

However, there are significant weaknesses in the application of these analyses and controls for bench-level experiments, maintenance, and equipment modifications in some facilities where hazard analysis and control is informal, inconsistent, and inadequate. There is a marked contrast in the analysis of work hazards and controls for routine activities at the reactor facilities and at the non-reactor facilities such as NSLS, AGS, and the Chemistry Laboratory. Much of this contrast is attributable to the more stringent requirements associated with the operation of reactor facilities. In addition, HFBR management has been proactive in the implementation of disciplined conduct of operations, and many staff have commercial and operating experience.

At non-reactor facilities, the approach to work planning and control, including the mitigation of hazards, is much less structured and formal, particularly for "in-house" maintenance and for small experiments or projects. Much of the work, including

High Flux Beam Reactor Experimental Floor

work associated with radiological, chemical, and industrial hazards, is conducted under verbal directions from managers and supervisors. Much reliance is placed on the workers' ability to recognize and control hazards. Examples of deficiencies in key elements of work planning and hazards control include:

- Lack of work packages that define the scope of work, identify potential hazards, and specify required controls
- No documentation of hazard analyses for many activities
- Inadequate application or integration of hazard controls, including permits (e.g., Radiation Work Permits and lockout/tagout), work instructions, As Low As Reasonably Achievable (ALARA) techniques, and physical protection mechanisms for electrical safety and radiological control
- Trained ES&H personnel and workers not consistently or sufficiently involved in work planning, hazards analysis and control, and work monitoring
- Outdated worker ES&H training and ineffective pre-job briefings that did not include ES&H personnel.

National Synchrotron Light Source Ultraviolet Ring and Beam Line Experiments

Weaknesses were identified in occupational radiological protection programs.

This safety management evaluation also identified a number of weaknesses in the BNL occupational radiological protection program in analyzing and controlling radiological hazards associated with facility activities and work. In some cases, doses exceeded pre-job estimates, pre-job and ALARA briefings were not documented, FSS technicians were not trained for all assigned responsibilities (e.g., industrial hygiene and safety), and required radiological surveys were not completed on schedule. Overreliance is placed on Radiation Work Permits (RWPs) as the only means to identify and control radiological hazards, and few work activities are conducted using approved procedures or work packages. Further, most of the RWPs reviewed contained only a very general description of the work activities, did not address limiting conditions such as exposure rates or contamination levels, and did not provide reasonable assurance that the radiological hazards associated with specific work activities will be identified, analyzed, and controlled.

Specific deficiencies noted in BNL radiation work practices include:

- Pre-job survey conducted one to two years prior to its inclusion in a RWP
- No record of pre-job surveys for radiological work; for example, cutting potentially contaminated piping
- No records of confirmatory surveys performed before workers are allowed to remove respiratory protection in airborne contamination areas
- No pre-job dose estimate, no ALARA reviews, and use of an unqualified radiation control technician for packaging of a contaminated component reading 81 R/hr

- Work performed on valves leaking tritium-contaminated water with no requirements for protective clothing or bioassay, and a requirement to frisk on exit with an instrument incapable of detecting tritium
- An absence of specific action levels for airborne tritium concentrations, with the determination of instrument alarm set points at the discretion of plant operators.

BNL has not kept pace with expectations for formality of operations.

Historically, the Laboratory has functioned in a less-structured manner; performance is driven by individual initiative and professional integrity, with little reliance on structured work planning or formal management systems. Review and analysis of BNL occurrence reports identified a number of avoidable events and near misses that are attributable to weaknesses in work planning and hazards analysis and control. Analysis of 1996 worker injury data indicates that approximately 70 percent of total work-related injuries at BNL are caused by ineffective work planning and control. These unnecessary and repetitive events and near misses at BNL do not support continuing the informal approach to identifying and controlling hazards. Effective work planning, hazards analyses, and hazard controls need not be elaborate or burdensome, and should be tailored in rigor and scope to the complexity and risk of the work activity. Management must ensure, however, that the identification and control of hazards is sufficiently systematic and structured to afford adequate protection and safety.

The event critique (see box on page 36) as well as the case study (see box on page 28) serve to illustrate the unnecessary hazards to workers that can result from informal and unstructured work planning. Although these electrical workers were not injured through contact with energized electrical equipment, there was a potential for serious injury. Electrical safety has been a growing concern within DOE because of the number and significance of electrical events or accidents including serious injuries and fatalities. In many reported events, including previous events at BNL, individuals were not actually injured, but experience a "near-miss" by contacting energized electrical equipment.

In this circumstance, the work was being performed without de-energizing the electrical panel so accelerator beam operations were not interrupted. Discretion to perform work on energized equipment should be limited to specific, narrowly-defined circumstances where there is no other option. Working on energized equipment in this case was not justified. When management does decide, however, that work must be performed on electrical equipment in the energized state, all reasonable and available hazard controls and worker protection mechanisms must be employed. In this instance there were numerous controls and protective mechanisms that were available and were required by site standards, but not employed:

- The work was not clearly defined through a work package or procedure; understanding the work is absolutely essential to identifying and controlling hazards.
- The hazards analysis was inadequate and did not identify the task as hot (energized) work.
- Available hazard controls for hot electrical work were not employed, including a lockout/tagout, hot work permits, or hot work procedures.
- Required safety precautions were not taken, including the use of rubber insulating mats and personal protective equipment, and conductive material was not removed from the individual (thus increasing the potential for electrical shock).
- Even when the EH team raised the safety concern about this work to BNL and BHG management, the unsafe work continued for another 24 hours.
- The lessons learned and corrective actions from similar previous electrical near-miss events and BNL assessments were not effective in preventing this occurrence.
- Work continued using a hot work permit that did not receive adequate management review (the blank hot work permits have photocopied signatures in the approval blocks).

Hazards analysis processes are not uniformly effective.

Institutional-level policies and standards provide many elements of a hazards analysis and control program. In general, hazards analyses and control are being effectively applied to reactor and

Event Critique—Electrical Maintenance

The Oversight team observed BNL Plant Engineering personnel performing modifications to equipment at the National Synchrotron Light Source in support of a future experiment. The work involved installing electrical wiring (pulling cables) and working in an "hot" (i.e., energized) electrical panel. Normal electrical safety practices require de-energizing electrical equipment to eliminate the potential for electric shock or electrocution. However, BNL personnel performed "hot" work to meet schedules for modifying equipment and to avoid impact on reactor availability for experiments.

The following is a summary of how ineffective work controls resulted in unsafe electrical work. As shown below, there were deficiencies in each of the five core functions of integrated safety management.

Define Work - The work control system was informal and had no criteria for work definition or work instructions.

- There was no work package and no work instructions, and work was defined by sketches that were not controlled such that they reliably reflect the electrical system configuration.
- The justification for performing "hot" work (so that beam operations were not interrupted and meeting schedules) was not consistent with applicable standards.

Analyze Hazards - Work controls did not provide documented criteria for analysis of hazards.

- ES&H safety professionals were not involved in safety reviews.
- Hazard analysis was not conducted for the work.
- The work was not properly identified (i.e., it was not specified as hot work).

Develop/Implement Controls - Work controls required by the BNL Operations and Maintenance Manual (1992) were not implemented. The informal controls were not adequate to ensure worker safety.

- There was no ES&H involvement and no verification of planned work against established requirements.
- Individuals involved were not familiar with the site requirements for hot work.
- A lockout/tagout, which is required by procedures and needed to protect workers, was not used.
- A hot work permit was not posted as required by BNL, NSLS, and Plant Engineering procedures.
- A generic hot work procedure was not at the job as required.
- Electrical safety and hot work training for the individuals and supervisor involved were delinquent.
- A Laboratory Electrical Safety Committee member was aware of the hot work, but let it continue.
- The hot work permit, at the job the next day, lacked job-specific information and justification for hot work.
- Plant Engineering supervisor and Department Head signatures were photocopied on the blank hot work permit, circumventing required job-specific management and supervisory reviews.
- Plant Engineering and NSLS electrical safety procedures did not meet site standards.

Perform Work - Work was not performed in accordance with requirements and was performed without adequate safety precautions.

- A Plant Engineering worker, on a metal stool, had his back inches from exposed 120 volt alternating current terminals on the panel door, creating an additional electrical shock hazard.
- A control zone to protect passersby and workers was not established as required.
- Protective drapes and insulated matting were not used (neither Plant Engineering nor NSLS had matting).
- The worker was not wearing safety glasses and did not remove conductive material as required.
- Work materials were being stored in the bottom of the energized panel.
- Workers had blocked open a fire door because the public address system could not be heard at that location.

Feedback and Improvement - Safety concerns were not corrected in a timely manner when NSLS and DOE personnel were informed. BNL's corrective action and recurrence controls from previous events and audits did not prevent recurrence.

- The work was still in progress 24 hours later; adequate safety precautions had still not been implemented.
- Corrective action from a previous BNL audit were not adequate to prevent recurrence.
- The corrective action specified in the event report was not adequate and was not completed as stated.

Assessment of Work Control Systems

Work on energized equipment without adequate planning and precautions places the worker at risk of electrical shock and electrocution. In this event, the BNL work control systems did not ensure worker safety. The electrical workers performed modifications on energized equipment without required permits, procedures, training, and adequate safety precautions. Some personnel did not demonstrate an understanding of requirements and did not take appropriate action when notified of the safety deficiencies. Although no injuries resulted in this instance, energized work has contributed to numerous events in the DOE complex, including serious injuries and fatalities.

accelerator operations and major modifications to equipment at BNL. There are significant deficiencies in other activities, including experiments, maintenance, and minor equipment modifications. Overall, hazards analysis and control processes are in need of improvement and warrant significant attention. Changing the approach to hazards analysis and control at BNL, including hazards associated with operations, maintenance, and experimental activities, will require acceptance and endorsement of a new approach and aggressive leadership and presence at every level of BNL management. The five core functions of integrated safety management—defining work, analyzing hazards, controlling hazards, working within the controls, and providing feedback for continuous improvements—could provide an excellent platform for achieving this change.

Operations Authorization

GUIDING PRINCIPLE # 7: The conditions and requirements to be satisfied for operations to be initiated and conducted shall be clearly established and agreed upon.

DOE has the ultimate responsibility for authorizing work and ensuring appropriate controls.

DOE has the ultimate responsibility for ensuring that the conduct of all activities performed at DOE facilities is authorized at the appropriate level. The level of authorization required is based on the type of work to be performed and the hazards associated with the work. Operations authorization involves determining an authorization basis for reactors and accelerators, and conducting operational readiness reviews (ORRs) for nuclear facilities and accelerator readiness reviews (ARRs) for accelerators. In addition, all work activities, including experiments, maintenance, and modifications, should also be subject to appropriate operations/work authorizations based on appropriate review of the preparations and readiness to perform those activities safely.

The operations authorization for DOE facilities is established via documentation that assures that hazardous facilities are operated within a defined safety envelope and in accordance with all applicable safety requirements and commitments. The operations authorization documents for the facilities reviewed include the safety analysis reports (SARs) for reactors and the safety assessment documents (SADs) for accelerators.

The AGS Will Play a Central Role in Operation of BNL's Relativistic Heavy Ion Collider, in Final Stages of Assembly.

In 1992, DOE made significant changes in its approach to safety analysis.

In 1992, DOE issued DOE Order 5480.23, Nuclear Safety Analysis Reports, requiring that all existing nuclear facilities upgrade their SARs. This order introduced the term "safety basis" in lieu of "design basis" because of DOE's recognition that the safety of the Department's nuclear facilities requires a balance of institutional and engineering approaches. In addition to the historical emphasis on engineered safety design and hardware, the order requires that safety analysis must address institutional and human factors relating to safety. The orders state that "Under the upgraded approach to safety analysis, working definitions of safety culture, operations safety, facility management and organization, and human factors safety must be agreed upon as part of the DOE review of the facility." The order also provides more rigorous requirements for a more detailed and systematic approach to hazard and accident analyses and a description and evaluation of the adequacy of safety systems and components. DOE Order 5480.30, Nuclear Reactor Safety Design Criteria, issued in January 1993, required existing reactors, such as HFBR, to evaluate the adequacy of their safety basis against the requirements of the order (including fuel pool performance and design criteria).

In September 1992, BNL submitted an implementation plan to DOE to meet the requirements of DOE Order 5480.23, Nuclear Safety Analysis Reports, to upgrade the HFBR SAR. NE did not approve the plan based on a high estimated cost ($6 million) and CH determined that the hazard categorization approach was not consistent with the implementing guidance for the order (i.e., Hazard Categorization and Accident Techniques for Compliance with DOE Order 5480.23). In May 1993, BNL, in response to a request from NE, evaluated the potential impact on HFBR safety if DOE Orders 5480.23 and 5480.30 were not implemented. BNL's report indicated that "reformatting" the SAR would not increase reactor safety and would still cost approximately 6 million dollars. CH did not concur with the report, which was considered an order exemption request. No further action was taken.

The safety analysis report upgrades were not considered a high priority by DOE management.

A revised implementation plan has been submitted and approved by BHG, with a commitment for BNL to begin revising the HFBR SAR in October 1997. However, funding limitations continue to delay this work. At the time of this review, funding has not been committed. These extended delays and failure to adequately determine the scope and cost of the SAR upgrade, involving NE, BHG, CH, and BNL, indicate that SAR upgrades were not considered a high priority by management. BNL's revised current estimate for the SAR upgrade is $500,000. Several updates have been made to the HFBR SAR to reflect plant changes or modifications, reactor power increases, and issues related to restart following a 1989 shutdown. While many elements of DOE Order 5480.23 may already be contained in

Alternating Gradient Synchrotron Ring

the existing SAR, updates are not as comprehensive as an upgrade to meet DOE Orders 5480.23 and 5480.30. An upgrade can help assure mitigation of the institutional and human factors risks, which were not an integral part of earlier-vintage SARs. The timely implementation of these two orders could also assist in identifying and mitigating design issues, such as the potential for spent fuel canal leakage.

DOE Order 5480.25, Safety of Accelerator Facilities, specifies the requirements for operations and facility authorization at accelerator facilities, including safety analysis documents, which contain the results of a safety analysis for the accelerator facility. The order also defines the accelerator safety envelope (ASE) as a set of physical and administrative conditions that constitute the bounding conditions for safe operation at the accelerator facility. While the order requires the DOE field office to approve the ASE, BHG only recently approved the AGS ASE and has not yet formally reviewed or approved the NSLS ASE. Further, DOE review and approval of the accelerator safety order implementation plans were not thorough, particularly as they relate to the basis for determining that no further action is required.

Authority to proceed with experiments varies across facilities and is not always effective.

The authorization for experiments to safely proceed varies widely among the facilities evaluated. The TRISTAN experiment fire in 1994, at an HFBR beam line, revealed a number of deficiencies in experimental safety control and in the authorization basis for experiments. Since that fire, HFBR experiments now require review by a team of technical and ES&H specialists, and there have been significant upgrades in such areas as radiological, electrical, and chemical hazards identification and control, training, and emergency response.

While these lessons learned do not appear to have been applied aggressively to experiments in other facilities at BNL, the authorization for experiments at AGS and NSLS appears to be generally effective. Authorization for experimental activities at AGS is governed by a series of safety committees reviews, which appear to be effective in identifying and controlling hazards. At NSLS, experiment authorizations are granted by the NSLS Safety Officer and documented on an experimental safety approval form; however, the hazard controls identified on the forms are not uniformly adequate.

The Chemistry Department policy on experimental reviews does not support the intent of the Laboratory SEAPPM on experimental control and safety and does not result in formal hazards reviews for most experimental activities, which are generally initiated and conducted by the individual researcher, without independent reviews or authorization from ES&H or management. The authorization for maintenance work that is performed "in-house" needs to be more structured to ensure an appropriate level of management approval, clear definition of the scope of work, and identification and control of hazards.

Although improvements have been made in operations authorization for reactors, additional attention is needed to control small-scale experiments and maintenance activities.

In summary, BNL has made significant improvements in experimental safety at HFBR, and the authorization of experiments at the AGS and NSLS accelerator facilities evaluated was found to be effective. Additional management attention to ES&H controls, including authorization of maintenance work and independent review of experimental hazards at the Chemistry Department, is warranted. Improvements and significant management attention ar warranted to upgrade the HFBR SAR and to assure continued protection of the workers, the public, and the environment related to HFBR operations.

3.0 Overall Assessment of Integrated Safety Management at BNL

Integrated Safety Management at BNL

OBJECTIVE OF INTEGRATED SAFETY MANAGEMENT: The Department and contractors must systematically integrate safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment. This is to be accomplished through effective integration of safety management into all facets of work planning and execution. In other words, the overall management of safety functions and activities becomes an integral part of mission accomplishment.

The overall integrated safety management for BNL needs improvement and significant management attention. (YELLOW)

Overall, the safety management program at BNL is not yet achieving DOE's objective of integrating work planning, hazard analysis, and hazard control into all levels of management so that work is performed safely. The results of this review indicate that BNL has effective work planning and control systems for those activities and facilities that are specifically designated as high hazard facilities and that are covered by stringent requirements, such as reactor operations at the HFBR. However, other activities, particularly those that relate to small-scale experiments and "in-house" maintenance, have few controls, although such activities (e.g., work on energized electrical equipment) can result in injuries and fatalities to workers. BNL accident and injury rates, while generally improving, continue to be higher than at most other DOE research facilities. Although tritium contamination at the HFBR and the subsequent discovery of contamination associated with the sump located near Building 801 do not immediately threaten public health, they indicate significant weaknesses in the safety management program, have eroded public confidence, and are very costly.

In the past few years, DOE and BNL initiatives have resulted in some improvements, particularly in areas where management has focused its attention, such as enhancement of conduct of operations at the HFBR. However, progress has been limited to specific locations and functions; some BNL facilities and activities lack a systematic approach to safety management and do not exercise effective work planning and hazard control. The "isolation" of facilities from each other, the absence of strong management direction and monitoring, and weaknesses in assessments, accountability, and corrective action programs have contributed to a situation where improvements in one facility or program are rarely extended to other facilities or programs that have similar problems.

Improvement needs to begin at the DOE Headquarters level with clearer definition of roles, responsibilities, and authorities, and improved coordination between multiple program offices in providing direction and ES&H funding to the Laboratory. The role of DOE, particularly CH and BHG, for the direct oversight of BNL safety management and ES&H performance needs to extend beyond the feedback received from performance metrics. Accountability for protection of the public, the workers, and the environment should be strengthened in the AUI contract and incorporated into the annual appraisals of managers at every level within DOE and BNL, including meaningful measurements, rewards, and sanctions necessary to achieve continuous improvement.

BNL needs to strengthen safety management and mandate from the highest levels of management that ES&H will be an integral part of all site activities. Achieving a stronger safety culture and balanced

priorities will require increased field presence by management and increased focus on ES&H performance in the three-tier assessment program. The management infrastructure and communications need to be strengthened to improve the prioritization, tracking, and timely resolution of issues, including regulatory commitments and corrective actions to internal and external assessments, events and accidents, and significant performance weaknesses in ES&H programs or safety management processes. These infrastructure improvements should assure that appropriate and responsible levels of senior management are aware of or involved in the status of these issues as well as related key decisions and allocation of resources.

Guiding Principle Ratings

One of the guiding principles (Guiding Principle #3, Competence Commensurate with Responsibilities) was deemed to have effective performance with respect to the established criteria. (GREEN)

Competence Commensurate with Responsibilities

The level of competence, particularly within BHG and BNL, was determined to be adequate in supporting safety management at the Laboratory. Although not significantly impacting overall safety management, however, improvements are warranted in specific areas, such as ES&H training and retraining programs for staff and visitors, technical staffing and skills mix within BHG, and the training and qualifications of BNL FSS technicians (radiation protection and industrial hygiene and safety).

Four guiding principles (Guiding Principle #1, Line Management Responsibility; Guiding Principle #5, Identification of Requirements; Guiding Principle #6, Hazards Controls; and Guiding Principle #7, Operations Authorization) were determined to need improvement and significant management attention. (YELLOW)

Line Management Responsibility

DOE and BNL management need to improve the level of management involvement and provide aggressive and effective leadership to improve ES&H performance at BNL. Increased management presence in the field is warranted to demonstrate commitment to ES&H; to obtain direct and timely feedback on ES&H performance; and to provide the coaching, training, and direction necessary to overcome resistance to change and make ES&H an integral part of all site activities.

Identification of Requirements

As new DOE orders and rules are written or revised, as well as the requirements of applicable regulators and BNL management, it is essential that these requirements be transmitted, incorporated, and implemented on a timely basis. The order requiring an upgrade of SARs to ensure that they meet increased reactor design, human factors, and institutional requirements was issued in 1992. Five years later, due to low assigned priority, funding issues, and organizational interface problems, the upgrade to the HFBR SAR has not yet been funded or implemented. The hierarchy of documents at BNL for implementing requirements, including the ES&H Manual (BNL Standards), sitewide SEAPPM, and department-level controls has not been fully effective in assuring that requirements are consistently implemented within each facility.

Hazard Controls

BNL has established effective processes for identifying and controlling hazards associated with major research activities, such as accelerator operations and major experiments. Significant upgrades to the control of hazards associated with HFBR beam tube experiments have also been implemented since the 1994 TRISTAN fire. However, analysis and mitigation of hazards associated with maintenance, smaller experiments, and other similar site activities are not effectively implemented. Work planning and control are informal and are lacking effective and systematic hazards identification and control, as evidenced by past occurrence reports and observations during this evaluation.

Operations Authorization

The operations authorization is essential to assure that facilities operate with defined safety envelopes that assure protection of the public, the workers, and the environment. The upgrading of the SAR for HFBR, a key component of the authorization basis for the reactor, to meet the requirements of a DOE order issued in 1992, is five years overdue and has still not been funded. Consideration should be given to completing this upgrade before HFBR restart to assure that the reactor design, human factors, and institutional controls meet applicable current requirements.

Two of the seven guiding principles (Guiding Principle #2, Roles and Responsibilities, and Guiding Principle #4, Balanced Priorities) were judged to be significant management weaknesses that require immediate management attention and resources. Improvements are essential to establish a strong integrated safety management program, minimize risks of BNL operations, and assure a continuing BNL mission and contribution. (RED)

Roles and Responsibilities

Immediate management attention is needed to clarify management roles, responsibilities, and authorities within DOE and BNL and to strengthen the mechanisms to achieve management and contractual accountability. Clear roles and responsibilities within DOE and BNL are essential to effective safety management, including issues management, the effective implementation of ES&H programs, establishing priorities, and the allocation of resources to ES&H. The roles, responsibilities, and authorities for BNL at DOE Headquarters have become less clear as responsibilities have shifted to field offices under the Department's strategic realignment. The roles and responsibilities for CH and BHG for direct management oversight of BNL ES&H performance are not well defined and appear to place too much reliance on monitoring performance metrics. BNL has not clearly defined roles and responsibilities for ES&H, particularly among senior managers. In the absence of clear roles and responsibilities and effective program interfaces, key commitments, such as the installation of groundwater wells at HFBR, get lost in the system.

Accountability for ES&H performance also warrants immediate management attention and action. Accountability mechanisms need to be strengthened for DOE and BNL managers at every level, including incorporation into annual performance appraisals. It is not unusual to encounter resistance to change within organizations, particularly when trying to implement a number of initiatives and substantially increase performance expectations in an area such as ES&H. This resistance can be overcome to some extent through increased management involvement and staff training, but complete success requires assigning specific ES&H responsibilities and holding managers and staff individually accountable for those responsibilities. The AUI contractual accountability mechanisms need to also be revisited by DOE. Although performance metrics were incorporated into the contract in 1995, these metrics are not effective in ensuring accountability for ES&H performance; in the absence of financial incentives and penalties, DOE has not implemented provisions to promote accountability for performance in a non-profit organization such as AUI.

Balanced Priorities

DOE and BNL, in some instances, have not achieved a responsible balance between ES&H priorities and mission-related objectives. This imbalance is evidenced in the five-year delay in installing groundwater monitoring wells at HFBR resulting from the very low assigned priority and reductions in funding. It can also be seen in the similar five-year delay in funding and implementing the upgrade of the HFBR SAR to meet DOE order requirements. Considering the complexities of DOE direction and funding for multi-program laboratories, such as BNL, a restructuring of the methods for prioritizing and allocating funding for ES&H and infrastructure needs may be warranted. This is particularly true at a time when continuing funding reductions threaten to create a further imbalance between ES&H needs, primarily funded from overhead accounts, and the funding of mission-related activities.

This issue of balance in priorities often extends down into field activities, including operations, maintenance, and research, where there is perceived tension between the freedom and creativity essential to scientific inquiry and the level of discipline

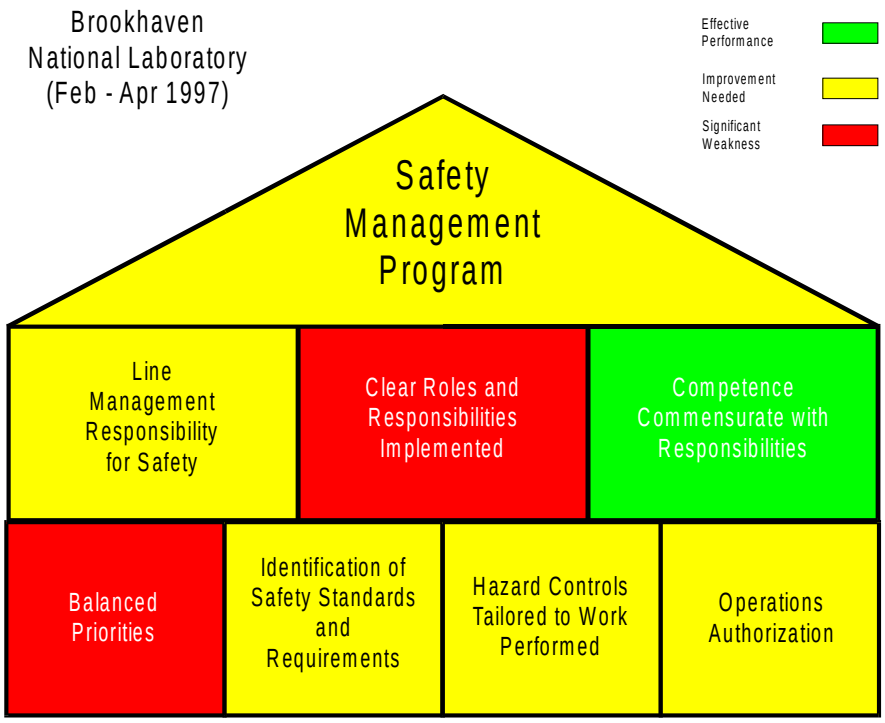


Figure 5. Ratings

necessary to control hazards and assure safety. There remain at BNL, as well as elsewhere in the DOE complex, pockets of managers and staff who believe that ES&H and research or other activities are not compatible. Structured work processes, such as systematic hazards analysis and the use of approved procedures, are viewed by some as impeding creativity and the ability to meet schedules and perform work efficiently. Overcoming this perception at BNL, and achieving recognition that ES&H and all site activities must be effectively integrated, will again require increased management presence and demonstrated leadership and support for ES&H.

The deficiencies in roles and responsibilities and balanced priorities were viewed as the most significant and requiring the most immediate attention because they are root causes of many of the other deficiencies. For example, the deficiencies in accountability and priority are a major contributor to deficiencies in the assessment programs and the failure to take action to correct identified deficiencies. Until these root causes are adequately addressed, other enhancements are not likely to result in sustained improvement.

The ratings are summarized in Figure 5.

4.0 Opportunities For Improvement

The safety management evaluation conducted by the Office of Oversight identified several opportunities for improvement. These potential enhancements are not intended to be prescriptive. Rather, they are intended to be reviewed and evaluated by the responsible DOE and contractor line managers, and prioritized and modified as appropriate in accordance with site-specific programmatic and ES&H objectives.

1. Strengthen CH, BHG, and BNL management involvement, visibility, and leadership in managing ES&H.

- Assure the understanding and effective implementation of ES&H policies, programs, and requirements.
- Increase senior management presence and visibility in the facilities, including ES&H leadership.
- Directly involve BHG and BNL senior managers in monitoring and managing the implementation of ES&H commitments, corrective actions, and regulatory requirements; establishing priorities; and making key decisions.
- Strengthen communications and coordination up and down through the organizations—within BNL, between BHG and BNL, and among BHG, CH, and Headquarters program offices—to ensure that the interests of all stakeholders are adequately considered in ES&H priorities, policies, and decisions.
- Develop a proactive, long-range strategy that builds upon existing mechanisms to ensure frequent participation by BHG and BNL senior management, and continuous citizen and stakeholder involvement in establishing sitewide ES&H goals and priorities.

2. Clarify roles, responsibilities, and authorities and strengthen the organizational, management, and individual accountability for ES&H performance.

- Ensure that senior managers and other managers remain ultimately accountable for ES&H responsibilities, authorities, and decisions that are delegated downward or to other organizations.
- DOE should consider modifying the AUI contract to strengthen financial incentives and sanctions based on ES&H performance, possibly through linkage to senior management compensation or discretionary research funding.
- Incorporate ES&H performance measures into the annual performance appraisals of managers and staff, and include appropriate rewards and sanctions.
- Assign final responsibility for decisions, commitments, priorities, schedules, and corrective actions related to ES&H to specific managers or staff rather than to organizations, committees, or working groups (single-point accountability).
- Ensure that the basis and responsibility for management decisions and priorities related to ES&H commitments, corrective actions, regulatory commitments, and funding are adequately documented so that organizational and individual accountability for decisions can be determined.
- Increase the percentage of time spent by managers and supervisors in the field observing and assessing ES&H performance, and increase accountability through more focus on performance in Tier I and II assessments.

- Strengthen the investigation of events, accidents, and adverse trends to identify and correct management and programmatic deficiencies and hold managers, organizations, and individuals appropriately accountable.

3. Strengthen DOE's monitoring and assessments of BNL ES&H performance and safety management.

- Re-examine, revise, and clarify documentation (i.e., memoranda of understanding and other agreements between DOE Headquarters program offices, between program offices and CH, and between CH and BHG) for authorities, responsibilities, and interfaces; ensure that these agreements are sufficient to provide clear and effective direction to BNL, provide clear responsibilities for decisions related to funding and priorities, and provide for effective monitoring of performance at BNL.
- Clearly delineate CH and BHG roles and responsibilities for ES&H in a manner consistent with DOE Order 411.1, Safety Management Functions, Responsibilities, and Authorities Policy (FRAM).
- Clarify ES&H line management oversight expectations and responsibilities for all BHG managers and staff, including establishing or updating position descriptions.
- Monitor the effectiveness of key BNL ES&H processes, such as issues management, allocation of ES&H funding, unreviewed safety question determinations, and hazards analysis and control.
- Establish a more formal and structured approach to BHG surveillance programs for facility and surveillance representatives, including setting expectations for time in the field.
- Implement periodic comprehensive assessments of the effectiveness of programs essential to ES&H, including radiation protection, industrial hygiene and safety, chemical management, conduct of operations, and work planning and control.
- Develop a tactical plan for utilization of CH resources to augment BHG staff for line management oversight and assessments in areas in which BHG is not adequately staffed, including radiation protection and industrial safety and hygiene.
- Continue some level of CH line management oversight and assessment at BNL until BHG has implemented an effective oversight assessment program that includes field assessments and the review and analysis of programmatic information, including occurrence reports and performance metrics.
- Develop and implement a BHG self-assessment program.

4. Strengthen management systems and procedures used by BHG and BNL to establish appropriate corrective actions (addressing the extent of conditions, root causes, and measures to prevent recurrence) and to prioritize, track, and implement corrective actions, commitments, and lessons learned.

- Establish and implement an integrated issues tracking system to assure that ES&H issues are properly captured, prioritized, tracked, corrected, completed as scheduled, and verified in a timely manner. Formally define the scope and responsibility for input, maintenance, and use of the system.
- Strengthen corrective action processes to ensure that extent of condition, root cause, and actions to prevent recurrence are addressed.
- Significantly improve management involvement in and support for the timely and effective resolution of ES&H issues, including the provision of appropriate resources, assignments to specific managers or staff, and escalation to progressively higher levels of management when actions are not completed as scheduled.
- Establish and implement a more structured BNL lessons-learned program to assure that lessons learned for events and accidents within BNL and throughout the DOE complex are communicated on a timely basis across the entire site and formally reviewed, and that appropriate actions are taken.

5. Establish a more structured, standards-based approach to the planning and control of work and related hazards.

- Beginning at the Laboratory Director level, clearly communicate ES&H performance

expectations, including endorsement of key ES&H programs and initiatives such as the DOE Radiation Control Manual, Work Smart standards, enhanced work planning, and integrated safety management.

- Improve consistency among the ES&H Manual, the sitewide SEAPPM, department- and division-specific SEAPPMs, and implementing procedures to assure that ES&H policies and requirements are accurately reflected and implemented.
- Strengthen the processes associated with controlling work and experiments, including hazards analysis, walkdowns of proposed work and hazards, comprehensive work packages, use of approved procedures and drawings, use of special permits (such as hot work and confined space), and comprehensive and timely pre-job briefings. Consider application of the five core functions of integrated safety management to all site activities without waiting for the longer-term formal implementation of integrated safety management.
- Formalize the job planning process to include trained job-planning personnel, worker involvement in planning and task procedures, and appropriate pre-job ES&H discipline reviews of hazards and safety controls, such as energy isolation, radiological controls, and personal protective equipment.
- Strengthen the sitewide radiological control program in identifying and controlling radiological hazards associated with work, including more effective use of ALARA planning, surveys, dose estimates, and radiation work permits.

6. Strengthen the implementation of sitewide training and qualification essential to safety management and ES&H performance.

- Provide a comprehensive and appropriate level of ES&H training and retraining for senior managers and other managers, including those with primary responsibility for ES&H.
- Establish and implement a comprehensive and structured initial training program for research facility users and subcontractors to assure their understanding of site and job hazards, safety policies and procedures, radiation protection, industrial safety and hygiene, chemical safety, lockout/tagout, and BNL management expectations for ES&H performance.
- Establish a training and qualification data base to allow supervisors and work planners to readily identify qualified individuals for specific work and ES&H hazards.
- Provide training on industrial safety and industrial hygiene hazards and controls for FSS technicians.
- Incorporate lessons learned for events and accidents at BNL and throughout the DOE complex into initial site general employee training and into training and retraining for resident managers and staff.
- Develop and implement a BNL instructor training and qualification program to ensure that all instructors, including mentors, experts, and supervisors who administer on-the-job-training, demonstrate an acceptable level of competence.

7. DOE Headquarters, including EH, program offices, and Field Management, should examine the issues raised on this integrated safety management evaluation and identify actions needed to address their complex-wide implications.

- Accelerate efforts to improve and restructure methods for funding ES&H-related activities at multi-program laboratories. These efforts should involve the Offices of Environmental Management, Nuclear Energy, Energy Research, Defense Programs, Field Management, and Environment, Safety and Health, working with CH and other field offices.
- Ensure the upkeep of the infrastructure at multi-program DOE laboratories and ensure that reductions in overhead funding do not unduly impact key ES&H activities, including: environmental monitoring and compliance; mitigation of the impacts of aging on systems, structures, and components; necessary upgrades to essential systems, structures, and components; required upgrades to the safety bases for facility operations; implementation of DOE orders, rules, and Radiation Control

surveillance of hazardous facilities and essential systems instrumentation and alarms during extended facility shutdowns; and ES&H training and retraining, including managers, staff, research facility users, and subcontractors.

- Emphasize contract reform efforts and ensure that effective measures to ensure accountability and meaningful rewards and sanctions are in place for not-for-profit institutions.
- Consider increasing DOE direct oversight of contractor ES&H performance and safety management through participation in key decisions; management walkthroughs and observations; systematic assessments of ES&H programs and processes; and continuing evaluation of performance information from occurrence reports, environmental monitoring, performance metrics, and other sources.
- Review and improve mechanisms for holding subcontractors accountable for ES&H performance.
- Review "gaps" in funding at multi-program sites and identify areas where Headquarters needs to better coordinate implementation of responsibilities.
- Clarify expectations for conforming with revised DOE orders and the order/rules exemption processes.

EVALUATION PROCESS AND TEAM COMPOSITION

The evaluation was conducted according to formal protocols and procedures, including an Appraisal Process Guide, which provides the general procedures used by the Oversight program for conducting inspections and reviews, and the Integrated Safety Management Evaluation Plan, which outlines the scope and conduct of the evaluation process. Training sessions were conducted to ensure that all team members were informed of the evaluation objectives, procedures, and methods. The evaluation team collected data through interviews, document reviews, walkdowns, observation of activities, and performance testing. Interviews were conducted with Headquarters, Chicago Operations Office, Brookhaven Group, and contractor managers, technical staff, hourly workers, and union representatives.

To emphasize the focus on the effectiveness of safety management systems, the team included a core group of seven safety management specialists (management team) whose role was to evaluate the overall application of the guiding principles and core functions of safety management. Specialists were assigned to focus on either management responsibilities (Guiding Principles #1 through #4) or requirements and implementation (Guiding Principles #5 through #7). Given the many linkages and interfaces of evaluation criteria and elements defining the guiding principles, the management team closely coordinated their efforts with the technical specialists who evaluated environment, safety, and health programs and implementation of the core functions of safety management at the facility level.

The team membership, composition, and responsibilities are as follows:

Deputy Assistant Secretary for Oversight

Glenn Podonsky

Associate Deputy Assistant Secretary for Oversight

Neal Goldenberg

Team Leaders

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Michael Kilpatrick

Safety Management Systems

Management Responsibilities

Charles Lewis, Group Leader
Robert Freeman
David Berkey
Frank Cicchetto

Requirements and Implementation

Pat Worthington, Group Leader
Roger Griebe
Robert Compton

Technical Specialists

Tom Staker, Group Leader
Kathy McCarty, Occupational Radiation Protection
David Allard, Environmental Radiation Protection
Chip Lagdon, Conduct of Operations
Ed Stafford, Conduct of Operations
Victor Crawford, Waste Management
Chris Perry, Groundwater Protection
Thomas Naymik, Groundwater Protection
Robert Crowley, Surface Water
Jim Lockridge, Industrial Safety/Industrial Hygiene
Mark Good, Maintenance
Marvin Mielke, Occupational Health

Administrative Support

Mary Anne Sirk
Tracey Blank
Thomas Davis
Kathy Moore

Quality Review Board

Neal Goldenberg
Mari-Josette Campagnone
Dean Hickman